THE

ELECTRICAL REVIEW.

VOL XLIX. AUGUST 30, 1901. No. 1,240.

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THE

UNIVERSAL ELECTRICAL DIRECTORY

1901 Edition

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A NEW THEORY OF BITUMINOUS COMBUSTION.

IN another column will be found an article upon the combustion of bituminous fuels, that places the subject in an entirely fresh light. We believe that this is the first time that the trouble and difficulty of burning bituminous coals have been attributed to the cause now advanced. Hitherto the trouble has been simply assumed to be due to the fact that the combustion of bituminous fuels is extended along a considerable length, and that the cooling effect of water surfaces prevents perfect combustion; but it has never, to our knowledge, been pointed out that the volatile constituents of coal, gaseous when distilled off, are locked up in a solid form in a lump of coal. In a piece of coal there exists solid carbon, solid hydrogen, solid nitrogen, and solid oxygen. Prof. Dewar has shown how great is the amount of heat required to be taken from the so-called permanent gases in order to reduce them to the liquid form, and how it is still more difficult to render them solid. Yet in a piece of coal there are several of the so-called permanent gases reduced to a state of apparently stable and permanent solidity. It matters nothing that this solidity has been brought about in Nature's laboratory of green leaves; there the fact is, and the solid coal will only dissolve into vapour at the expense of heat, exactly as a lump of ice dissolves to water or to vapour at the expense of the heat in surrounding bodies.

Carbon vapour generates, when completely burned, more than 20,000 units of heat per pound. Solid carbon generates less than 15,000 units. If, therefore, a piece of solid carbon be gasified before combustion, it will absorb nearly 6,000 heat units per pound in the process, and will, when burned as gas, give out over 20,000 units. The net result is under 15,000 units. Now carbon can easily be boiled off into gas if combined with hydrogen—easily, that is to say, so far as regards a moderate temperature. Without hydrogen, carbon gasifies at the high temperature of 3,600° C. With hydrogen, it gasifies at 1,000° F., or less. Nevertheless it absorbs, or renders latent, the same amount of heat in each case, and it can only obtain this heat from an outside source. In gas making it obtains it from the retort-heating furnace. In the steam boiler it obtains it from the incandescent fuel on the grate. Properly conducted, in suitable furnaces, the final heat product is the same, but the solid carbon, burning on the grate, is compelled to add about 6,000 heat units to each pound of the volatile hydrocarbons, in order that these may burn, later on, with an increased intensity. Hitherto, careless thinkers have pronounced the hydro-carbons so difficult of combustion, that

it was not worth while attempting to burn them, and their deliberate waste has been advocated. It is now clear that if the volatile parts of coal could be caused to escape entirely unburned, the fuel efficiency might be as low as 25 per cent., for the volatile hydro-carbons carry with them, not merely their own calorific capacity, but also the latent heat bestowed upon them by the solid carbon they leave burning on the grate. This view enhances the importance of completely burning the hydro-carbons. It also puts a much more hopeful aspect on the possibility of doing this, for it explains why so many well meant efforts have been hopelessly wrong. If want of success has plainly been due to following wrong methods, the outlook is so much the more hopeful than if failure had accompanied correct methods. It only remains to follow correct methods for success to be assured.

In dealing with liquid fuels, perfect combustion has been much easier to secure than it has been in the case of solid fuels, consisting only partially of volatile hydro-carbons. The theory now advanced serves to explain this. Liquid hydro-carbons are already well advanced along the path of vaporisation, just as ice is a long way advanced towards the state of vapour when it has been melted down to the intermediate state of water. Coal, petroleum, and illuminating gas are related to each other much as are ice, water, and steam. Judged by its empirical formula, petroleum should not have a calorific effect superior to that of coal, such as it possesses. The explanation, of course, is that, being already liquid, there is so much less heat required to gasify it than is the case with solid coal.

Everything in fuel combustion is quite consistent with the new theory, which is based simply on figures obtained by chemical and physical experiment. It is a little startling to find that average samples of bituminous coals may produce barely a fourth of the heat of their combustible constituents upon the grate itself. True, nearly half the heat is generated by the fixed carbon which burns on the grate, but so much of this goes to evaporate the remainder of the fuel, that nearly three-fourths of the heat effect of bituminous fuel is exerted beyond the surface of the fuel on the grate. Some long-flaming coals there are whose flame extends 90 ft. from the fire; these are the coals that make most smoke under unfavourable conditions. The drier shorter flaming coals will complete their combustion in much less space. High temperature in all is essential.

Trade Unionism and British Industries.—Benjamin Taylor, who insists that British trade and industry are not in the parlous state that many writers describe, admits in an article in the August *North American Review* (New York) that British trade is crippled by trade unionism, "which enhances the cost of production by restricting the output." He says:—"The British trade union is an organisation for the restraint of labour and the manacling of capital. If American manufacturers are enabled to undersell their British rivals in some of their pet industries, it is not because the American workman is a better craftsman than the British, but because he is an unfettered producer. That is to say, American labour is more productive than British. The great object in American production is the saving of labour. The great object in British trade union production is the dissipation of labour—which is waste. This is the central idea of the 'machine question' among the engineers of the eight-hour-day movement, of the miners' weekly 'idle day.' The less each man does for his wages, the more will there be for other men to do for the same wages—so they foolishly think, as if there were a common wage fund into which every man can dip, share and share alike with his neighbour. This is why all labour-saving machinery is still hated by British working men, almost as much as it was in the days of the Luddites. Men do not smash machine tools nowadays, it is true; but they manage to get the minimum of work out of them, and to extract the maximum pay for attending to them. And that is why it has been computed that, if the numerals 1 to 1¼ be taken as representing the producing capacity of the British workman, 2¼ must be taken as representing the producing capacity (not the technical skill) of the American workman. The objects of the British trade unionist are—to equalise the wage of the mediocre or inferior and the capable workman; to restrict the amount of work done by each workman, so that there may be fewer unemployed; to restrict the total output, so that prices, and consequently wages, may not be borne down by the over-supply. In carrying out these objects, then, the British trade unions are neither more nor less than organisations for the restraint of labour and the curtailment of production."

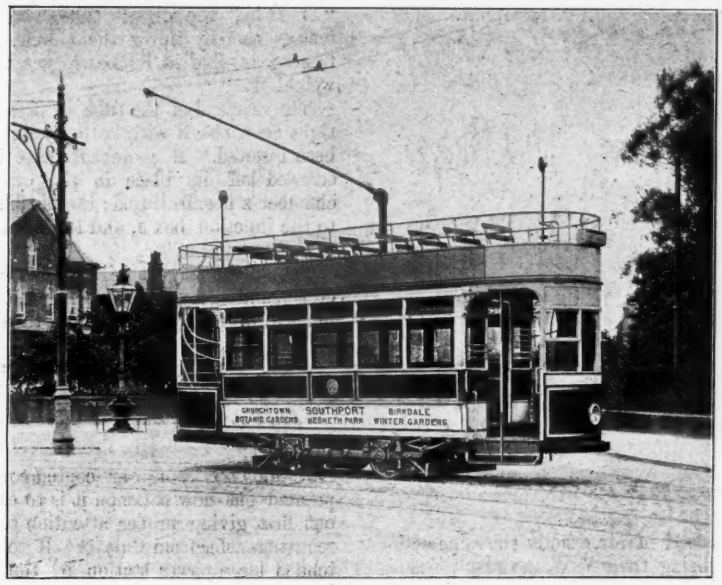
The Belleville Trials.—On Saturday last the report upon the trials of the *Minerva* and *Hyacinth* was published. When the trials had been made, we read an article in the *Times* which practically awarded the palm to the *Hyacinth* with Belleville boilers. It appears, however, that the results were very much the other way. On the race home from Gibraltar the *Hyacinth* burned about 25 per cent. more coal than the *Minerva*. She also used up all her emergency water and kept her evaporators going all the time. The emergency fresh water reserve was 140 tons. The Belleville boilers, in fact, leaked badly. One of them, No. 10, indulged in the customary bye-play of bursting a tube and scalding a mere man, but he was, we believe, only a common stoker, and not a Vice-Admiral or a First Lord, so that was no matter. It would have been a sad thing to have scalded the President of the Boiler Committee. The sting of the report comes in its tail, which holds a three-page list of the defects of the *Hyacinth's* boilers. These defects are placed under the heads of "curved upwards," "sagged," "feed collectors' junction box doors leaking." They are a formidable array, and point to over-heated tubes, and generally to the total unsuitability of the Belleville boiler for serious work. The whole business has been a blunder from the first. It has degenerated into a farce. Whether it will attain the magnitude of a crime must depend upon whether those responsible can bamboozle the Admiralty in the future as in the past. Everything points to a strong effort to bolster up this wretched Belleville business. The country will be wanting some explanation.

Ah Sin or Mac?—They are an enterprising and progressive people in Dunedin, and do things well at times. It was in Dunedin that an ingenious Ah Sin—there are many Chinese about the Otago diggings—once made a famous attempt to break through the Scottish "ring." A contract was advertised by a Town Council, and when all the tenders came in, the lowest—from one Alexander Macfarlane—was selected, and the would-be contractor written to and invited to call and sign the necessary papers. At the appointed time a bland Chinaman appeared and answered to the name. "But, look ye here, mon," said the surprised head of the Council, "yer name's no' Alexander Macfarlane, surely?" "Allitee," said the Celestial, "me savee this pidgin—supposee no gottee name belong 'Mac,' no gettee contlact!"—*M.A.P.*

SOUTHPORT ELECTRIC CARS.

The cars for the new electric system of the Southport Tramways Company, which were manufactured complete by the Brush Electrical Engineering Company, Limited, are of the four-wheel top-seated type with reversed staircases, and screens in front to protect the driver, seating 22 inside and 34 outside. They are handsomely fitted up inside, with millboard roof painted white and picked out in gold. Swing ventilators are fixed at the sides over the windows, and cushion seats and roller blinds are provided.

The motors used are of a special kind, and have been designed to the requirements of Mr. Raworth (the chairman of the tramway company) to meet the case of a tramcar running on a perfectly flat line, and fitted with roller bearings. It is confidently expected that the combination of the roller bearings with the special motors will reduce the amount of energy per car-mile to something like one-half the amount that is used on other lines.



Electric Tramcar for Southport.

The controllers are of the series-parallel type, with an electrical emergency stop. By means of this brake the car can be pulled up in less than one-half of its length.

A further speciality is the construction of the trolley heads. These are made of aluminium, which being so much lighter than gun-metal, allows the trolley poles to be of more slender dimensions and enables surer contact to be made with the trolley wire.

The trucks are of the standard four-wheeled pattern adopted by the Brush Company, who are proud of the fact that they now produce trucks to fill every possible requirement of tramways, light railways and heavy railways of a design and excellence second to none, and that they are the only firm in this country who manufacture complete electric cars.

DISCHARGING TORPEDOES BY ELECTRICITY.

Torpedoes are launched, as a rule, from tubes which are very much in the nature of a gun, the torpedo being ejected either by air pressure or a small charge of powder in the rear of the tube. The torpedo as it leaves the tube has its air lever thrown back by a projection against which the lever strikes as the torpedo passes; this admits air to the engine, but not at full pressure. There is a second lever, known as the "water tripper," and it is not until this is thrown back by the friction of the water that the engines are working at full speed; thus the sudden strain that would be brought upon them by the rapidly revolving screws being plunged into the water is avoided. The screws are only revolving at a very moderate speed during the interval between leaving the tube and entering the water.

The impulse is "fired" by electricity from the conning tower, where the director, which bears the same relation to a torpedo tube that the sights do to a gun, is placed.

The director consists of a graduated arc upon which moves an arm pivoted at the centre of the arc; this arm represents the torpedo tube in miniature and is aimed at the object, its position either before or abaft the beam being passed by telephone or voice-pipe down to the tube, which is laid accordingly by the crew attending it.

Now, in directing the course of a torpedo, the speed and direction of the enemy must be taken into account, and allowance must be made accordingly; thus, if the enemy is passing at the rate of ten knots on a course parallel to that of the attacking ship, which we will suppose is going at the rate of five knots in the opposite direction, it is obvious that the combination of speeds will make the enemy's apparent rate of approach greater than it really is, for her motion in relation to the attacking ship will be 15 knots. In gunnery this apparent speed becomes real, because the projectile in its course through the air, retaining practically all of the lateral motion it derived from the ship, still approaches its target laterally at the rate of five knots, whereas in the case of the torpedo moving through a much denser medium the lateral motion is lost almost directly it enters the water, consequently only the enemy's speed must be taken into account. Suppose then that our torpedo is set to go at the rate of 20 knots, its speed being double that of the enemy's ship, in order to score a hit we shall have to direct our torpedo to the point to which the enemy will have advanced when the torpedo has covered the distance between the two courses.

The present case is a simple one, and involves the solution of a right angled triangle in which the two containing sides are respectively represented by the course of the enemy, and the direction of the torpedo; these two directions will be represented in length by a proportion of 10 to 20, which gives us an angle of 30° between the hypotenuse and the torpedo's course. Thus when the enemy bears 30° before the beam, in order to score a hit, the torpedo must be fired directly on the beam. Where the courses are not parallel, however, the case becomes more complicated, and the triangle ceases to be right angled.

For the purpose of quickly solving such a triangle the director is designed; it consists of three sliding bars, upon one of which the enemy's speed is represented by a graduated scale (see fig. 1). The second bar is graduated to represent the speed of the torpedo, and the relations of one to the other are made by sliding out a bar upon which sighting pieces are fixed, and which takes the place of our original hypotenuse. These bars are pivoted freely upon one another, and that which represents the hypotenuse can be extended at will. In this manner, a triangle is formed, the nature of which is determined by placing the enemy's bar in a direction identical with his actual course, and the torpedo bar in the position from which it is intended to fire the torpedo, the sights upon the third bar will then show the line which the enemy must cross at the instant of firing. The director is placed in the conning tower, and therefore the operator is at some distance from the tube he is working, consequently the use of electricity becomes the most effective means of discharging the torpedo at the instant when the sights indicate that the right position has been attained.

If the torpedo is to be fired by air pressure, upon the key being pressed an air valve is thrown open, which admits a large volume of air at high pressure into the chamber of the

tube to the rear of the torpedo. The accompanying diagram (fig. 2) shows how this is effected. F is the firing key, which completing the circuit from the battery A to earth, excites the electro-magnet M, and thus, attracting the soft iron armature C, releases a spherical weight W. This weight is attached by an arm to the rod R R, and falling outward causes this rod to revolve in its bearin , carrying with it a cam (not shown in the figure), which, s iking against the valve, depresses it and so admits the air which discharges the torpedo. G is a 1,000-ohm galvanometer, which may be switched into the circuit just before firing, in order to ascertain that all the connections are in working order, and that the circuit is complete; its high resistance obviates the possibility of accidentally firing the tube while testing the circuit. When

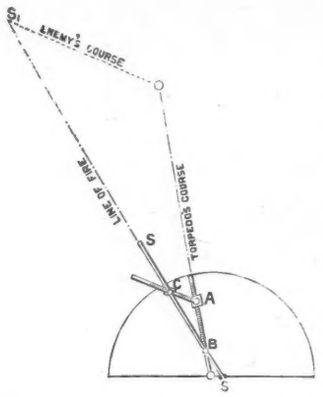
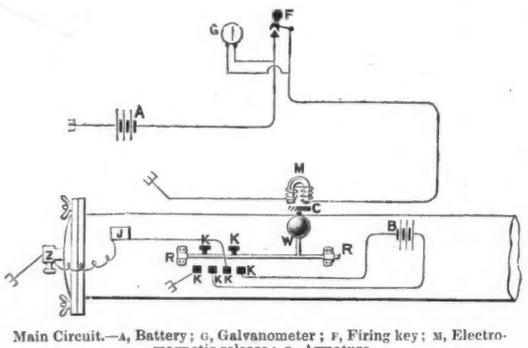


Fig. 1.

using powder-impulse instead of air, exactly the same action takes place, but the air being turned off, no result follows the opening of the valve. In this case the weight, in falling, makes contact in a second and quite independent circuit, which ignites the charge by means of a fuse.

In order to trace this second circuit, we must imagine the weight to have fallen, when contact will have been made between the groups of contact pieces K.



Main Circuit.—A, Battery; G, Galvanometer; F, Firing key; M, Electro-magnetic release; C, Armature.

Local circuit.—B, Fuse battery; K, Contact pieces; J, Junction box; Z, Fused cartridge chambers; R R, Safety rod.

Fig. 2.

We will trace it from each pole of the battery B to earth. Starting from the negative pole, we come to the first contact, which is found by the piece on the rod bridging the space between the two right-hand lower contacts. This completes the circuit to J, which is a small junction box. From J the current passes into a flexible lead, which is brought through Z, the cartridge chamber, to the fuse; crossing the platinum bridge of the fuse, it goes to earth in the cartridge case, which, being made of brass, is in metallic contact with the tube.

From the positive pole the current passing the left-hand contact group goes to earth in the tube again. We have now to examine the safety arrangements.

A torpedo is discharged from very near the waterline, and therefore it is necessary to have large torpedo ports in order to prevent water entering the tube in rough weather; if, by some mischance, this port were forgotten in war time, and the torpedo were fired, the consequences would be most disastrous; in fact, the torpedo would probably explode in the tube and blow it to pieces, disabling the ship instantly. To avoid this, means must be provided which make it impossible to fire with the port shut, or even unless the port is fully open, and this will be effected by making it impossible for the weight to fall when the port is in any position other than wide open.

The rod, R R, therefore, terminates in a clutch, which fits into a bar capable of becoming disengaged by levers, which move with the port as it opens, and upon the order "stand by," the torpedo tube's crew, lifting the port with tackles, thereby throw the clutch out of gear, leaving R R free to revolve in its bearings with the dropping of the weight W.

The rear end of the tube is fitted with a hinged water-tight door, closed with butterfly nuts after the torpedo has been inserted. If powder impulse is to be used, a cap is screwed off its place in the centre, and the cartridge chamber Z is substituted; the flexible lead is then joined up to the junction box J, and the word "ready" is passed up to the conning tower.

Should the magnet fail to release the weight, one of the crew standing by, upon hearing the word fire as the key is pressed, lifts the armature, and thus fires the torpedo.

WATER SUPPLY FOR POWER STATIONS.

Not any too soon our contemporary, the *Engineer*, has pointed out how common it is to erect power stations without first giving proper attention to the water supply. The recent transfer from Camberwell to Greenwich of their intended large power station, by the London County Council, is a case in point. The only water supply available at Camberwell, apart from the extravagantly costly and hazardous dribble of the water company, is that from the superficial gravel beds or from the chalk below. The gravel water lies about 20 ft. below the surface, and is not plentiful. The chalk supply is perhaps 70 ft. below the surface, and, for London, is fairly plentiful, but is in all probability not nearly equal to the demand that would be made. For each 1,000 H.P. in a tramway power house it is hardly likely that a less supply than 3,000 gallons per hour would be needed for steam purposes alone, while for condensing purposes the amount would be 75,000 gallons per 1,000 H.P. per hour, unless, indeed, very commodious water-cooling apparatus was provided, when possibly the total water supply would be under 3,000 gallons per hour per 1,000 H.P. But we believe the expense of water cooling had decided the Council to employ high pressure, *i.e.*, non-condensing engines. Now, if there is one place above another where condensing will pay handsomely, it is in a tramway power station. Given steam at 150 lbs. pressure absolute and a cut-off at an eighth of the stroke, the net forward pressure non-condensing will be about 42 lbs.

Assume, however, a full load expansion of only four times; then the mean pressure is about 72 lbs. As the load factor is hardly likely to exceed 70 per cent., there remains an average mean pressure of about 50 lbs., so that the addition of a 12-lb. vacuum represents a very large percentage of saving. Many men who are responsible for the design of electric stations appear to have read in some text book that with modern high pressures the value of condensing is much diminished. Apparently they entirely fail to grasp the conditions that surround the average tramway power station, especially with compound engines.

In the first place, the compound engine sets a limit on the admission of steam, and compels an expansion at least fourfold in ordinary conditions and with customary engine proportions. This cuts down the mean effective pressure very considerably.

Secondly, the load factor of a tramway station is so small that the mean pressure is often reduced by half, two-thirds, or even in some existing systems more than four-fifths of the full load mean pressure. With such

conditions the relative value of a vacuum of 12 lbs. is very great. It will always pay to employ cooling towers for cooling the water for condensing in preference to throwing high-pressure steam into the air uncondensed, but it is, of course, far better to fix upon a site for a station where water is easily obtained in large quantity, such as by a river or canal. Our contemporary suggests that the ease with which ships obtain water for condensing purposes may have something to do with the extraordinary neglect of this, one of the first requisites of a power station. But this can hardly be the case, and we can but attribute the fact to the extraordinary indifference of many electrical engineers to well established facts. High pressure working and cold feed water are some among the many faults that steam engineers lay to the charge of electricians, who are, they say, responsible for a backwardation of 50 years in all that relates to good practice.

We have seen boiler houses built within the past few years that fall far short of sound engineering. High pressure steam ought to show economy, but with high pressure ought to go the ability to control it and to understand it, otherwise no benefit, but only loss, can follow.

It is at least satisfactory to find that the bad practice proposed by the London County Council has been nipped in the bud before it was too late.

REVIEWS.

Electric Lighting. By F. B. Crocker. Vol. II.—Distributing system and lamps. E. & F. N. Spon, Ltd. 1901. Price 12s. 6d.

This volume covers all parts of electric lighting systems outside of the generating plant already dealt with in Vol. I. It may, from the reader's point of view, be divided into six sections, dealing respectively with conductors, distribution generally, and networks; alternating current systems and transformers; mains, or methods of erecting overhead conductors, and laying underground mains; the arc and arc lamps; wiring and incandescent lamps; and last, supply or integrating meters. Like the preceding volume, the general character of the apparatus treated has relation to the types and forms most commonly met with in the United States. This is hardly an objection in the present day, when the American invasion is the common subject of talk, and of articles in the Press. The student and engineer will be none the worse for a little acquaintance with the manner in which things are done across the Atlantic, and if such a book as this tends to break down some of the insularity with which we are sometimes twitted, so much the better. That much of the practical matter cannot be directly applied in an English central station, or that the mains are not usually laid in wooden pipes or Edison tubes may deter some from adding the book before us to their library, but Prof. Crocker seems to have recognised this by limiting his practical descriptions to a few pages (pp. 262 to 296), while the theoretical principles of design are fully gone into. To say that cast-iron pipes have no great advantages over wrought-iron may be true in the author's country, but it is hardly so here, while to give the Edison system some six pages and to deal with the Crompton, Kennedy, and Callender's systems in a couple of pages, and omit the B.I.W. solid system, distinctly marks the book as American. The Ferranti solid main is described as if it were still in use. In dealing with ventilation of conduit systems, no mention is made of inlet ventilators on the street level, or posts, although the up-cast connection to lamp columns is illustrated. Similarly, the transformers described are those in use in the States. The Ferranti rectifier is mentioned on p. 217, but is passed over in a few lines, while a terrible example of a "constant current transformer" (something like the 1894 pattern of Ferranti C.C. transformer) is shown on p. 172. The Stillwell regulator appears on p. 197. It is a pity that the current pattern of Ferranti rectifier, constant current series transformer, oil-break fuse, and Cowan and Still's booster or regulator were not included, as these represent the most advanced and simplest forms of the respective apparatus.

The book generally follows the lines of A. V. Abbott's well known and elaborate treatise on the "Electrical Transmission of Energy," and many of the diagrams in the earlier pages are similar, but the explanations are given in greater detail, and in some cases are more readily followed. The principles of distribution are so well stated that we can recommend this work to the student who may have to design networks in later years. The arrangements of tapering and conical conductors, methods of feeding at similar or opposite ends, feeder regulation, three-wire balancing, and the like, are among the questions most thoroughly considered. In general, we have found that if descriptions of apparatus or plant are desired, the best explanations are to be found in English works. On the other hand, one is well served by American writers when principles or theoretical discussions are sought, and in this respect the book before us is excellent.

The section on the arc should be supplemented by a summary of Mrs. Ayrton's and Mr. Duddell's work. As it stands it represents the views held prior to the investigations which have attracted so much attention in the last two or three years. The arc lamps described are of patterns little known in this country: probably the student would find Maycock serve his purpose better than Chapter XV., to say nothing of the voluminous matter which is available from the pen of Dr. S. P. Thompson. Street arc lamps in this country would not be tolerated on wooden masts with lowering ropes; here again the book has nothing to tell English engineers, nor is the practice in this country as regards interior wiring quite the same as Prof. Crocker gives. In the chapter on "Meters" the Edison chemical, "Thomson recording wattmeter," Shallenberger, Westinghouse, Duncan, Gutmann, Marks, Ferranti and Aron types are described at varying length, nothing being said about the Hümmel or Hookham motor meters or the Brillié and others of quasi-motor types. The rules of the National Board of Fire Underwriters take the place of those of the Institution of Electrical Engineers or the Phœnix Fire Office, which would be found at the end of an English work of the kind.

Altogether, Prof. Crocker has produced a useful book for those who wish to make themselves acquainted with current American practice. Many points were noted for comment about which we have said nothing, as to refer to them would lead to a dissertation upon the divergence of American from English lines of thought and action. But read in conjunction with some of the better known and more commonly used works of home origin, this book is sure to prove useful and instructive, being especially so in connection with direct current three-wire distribution and the principles of alternating single and polyphase transmission.

Archives of the Röntgen Ray. Vol. V., Nos. 1 and 2.

These two numbers contain many valuable papers read before the Röntgen Society, a number of excellent reproductions of Röntgen photographs, and other matters of interest to students of the X ray. The presidential addresses of Mr. Wilson Noble and Dr. Macintyre give excellent summaries of the state of the science and its practical developments at the dates on which they were delivered. Mr. Noble emphasises the necessity of using soft tubes for obtaining photographs of the thicker parts of the body. The soft tubes produce a greater contrast between bone and muscle, and this is especially necessary where the thickness of the latter exceeds that of the former. The exposures with soft tubes are, unfortunately, longer, but this Mr. Noble thinks may be got over in the future by devising tubes which will stand larger currents. Dr. Macintyre's address deals very fully both with recent apparatus and scientific developments. The most remarkable new generator of current for X ray tubes appears to be Prof. Trowbridge's high-pressure secondary battery. With this battery, currents at a pressure of 40,000 volts can be generated directly, and this pressure has been found to be amply sufficient to get the maximum effect from X ray tubes. The current in the tube was found to be exceedingly small—less than 10 milliamperes.

It appears still to be the opinion of certain authorities than neither medicine nor surgery has derived any great advantage from the discovery of the Röntgen rays. In the face of some of the results mentioned by Dr. Macintyre, this pessimistic view cannot much longer be held; for example, he says that Leonard, of Philadelphia, affirms that not only can calculi in the kidneys be detected by the X rays, but that where a negative result on the photographic plate has been obtained, no stone is present. Röntgen rays have proved of great use in the larger military hospitals in South Africa, but of little use within or near the fighting line; the failure in the latter case being no doubt due to the delicacy of the apparatus and the cumbrous character of the generators of electricity.

Drs. Wolfenden and Forbes-Ross describe a number of careful experiments which they have made to ascertain the effect of X rays on micro-organisms. Contrary to what has previously been asserted, they found that the X rays stimulated the growth of these organisms. The fermentation of yeast was stimulated by the X rays, a circumstance which deserves the attention of brewers.

Mr. Wimshurst describes the work he has gone through in the last 20 years towards perfecting the influence machine. His paper shows that he has worked indefatigably to give practical form to the type of machine associated with his name, but he characteristically ignores the work of his predecessors in this field, who anticipated a great deal of what he has done.

Mr. Mackenzie Davidson describes his excellent stereoscopic fluoroscope and rotary mercury break, but as these have already been more than once noticed in the Electrical Review, further notice here is unnecessary.

Dr. Delpratt Harris describes a self-heating focus tube in which the cathode rays from the back of the aluminium disc are utilised to heat the surrounding glass, and keep the tube soft. A new X-ray photograph film by Mr. Chisholm Williams consists of a double emulsion film, which is strong enough to bear handling without a glass or celluloid plate. There are several other valuable papers, which well deserve attention from those interested in the special branches with which they deal, but which want of space compels us to ignore.

FURNACE TEMPERATURES.

By W. H. BOOTH.

I have already advanced in previous numbers of the Electrical Review, as an argument in favour of the necessity of refractory furnaces for bituminous fuels, that only a proportion of the total calorific capacity of a bituminous coal is generated on the grate, and therefore the fuel which burns on the grate is debited, not only with its own combustion, but also with the splitting up of the hydro-carbons and other volatiles, and the raising of them to such temperatures as will enable them to burn at a second zone of combustion. It is difficult to gain acceptance of these views, and it is certain that furnace and boiler designers have not, as a rule, even recognised the facts that give rise to them. Perhaps one of the best arguments will be to take the case of some actual fuel, calculate its various calorific capacities, and follow its combustion throughout.

An average of 18 analyses of Newcastle coal gives the following figures:—

Fixed carbon	48·84 per cent.
Volatile carbon	33·29 ,,
Hydrogen	5·31 ,,
Oxygen	5·69 ,,
Nitrogen	1·35 ,,
Sulphur	1·24 ,,
Ash	3·77 ,,
Calorific capacity	15,202 B.Th.U.

The calorific capacity of amorphous carbon is about 14,647 B.Th.U. per lb., therefore the capacity of the 48·84 per cent. of fixed carbon in the above samples must be 7,150 B.Th.U. Now, so far as regards the fire upon the grate, these 7,150 heat units are all we have to work with. By their means we have to split up the hydro-carbons, or rather we have to draw on them for the heat which becomes latent in converting the solid coal to gaseous hydro-carbon. Moreover, a piece of coal is all solid, and, excepting the ash, it all becomes gaseous. Therefore, subtracting for cinders 3·77 per cent., there remains 47·4 per cent. of volatile solid matter which ultimately passes off in a gaseous state. The customary allowance of air is about 18 lbs. per pound of coal. This also must be heated up to the general temperature by the heat developed on the grate by the fixed carbon only.

The theoretical flame temperature of carbon, when burned in an exact sufficiency of air (*i.e.*, 11½ lbs. per pound), is 4,892° F. We can readily calculate the net temperature of all the products in the usual manner, though the result will be approximate only. We may assume 1 lb. of coal, and we will add the customary 18 lbs. of air, so as to produce a final 19 lbs. of total furnace products. As the temperature of combustion of carbon in air is 4,892°, when using 11·6 times its weight of air, the temperature with 18 lbs. of air will be $\frac{12{\cdot}6}{19} \times 4{,}892° = 3{,}245°$ F. But with the heat produced by 48·84 per cent. of the coal, we have to carry the further load of volatile fuel and inert ash that is not burned on the grate, together with its similar proportion of excess of air. The temperature of $3{,}245° \times {\cdot}4884 = 1{,}584°$, and this is the maximum temperature of the products of combustion, assuming that they escape uncooled. This is a maximum figure, because whereas the temperature of combustion in air, namely, 4,892°, is that due to a minimum of air, the reduced temperature involved by the use of excess of air, as above calculated, is really too great in part proportion as the specific heat of nitrogen is greater than that of carbonic acid; nitrogen, of course, forms by far the greater proportion of the furnace products, and it has a specific heat of 0·244, as compared with carbonic acid, 0·217. Steam, also, which is formed on the grate and does its share in reducing the temperature, has the high specific heat of 0·480, any free hydrogen that may escape has 3·410, and the hydro-carbons have also very high specific heats; for example, Olefiant gas, 0·418; Marsh gas, 0·593.

It is thus clear that the temperature of the gases, as they flow to the bridge, is quite low, and so far no deduction has been suggested for the vaporisation of fully half the solid fuel into the gaseous form. What, in fact, is the effect of the latent heat of evaporating carbon, hydrogen, oxygen, from the solid?—for this is really what happens when bituminous coal is burned.

To evaporate carbon requires 5,817 British thermal units per lb., this being the difference between the calorific capacity of carbon burned to its monoxide, and of this monoxide burned to dioxide respectively. Hydrogen and oxygen combined require 11,000 heat units per lb. of hydrogen to raise them from the solid to the gaseous state.

Let the figure of 7,000* units of latent heat per lb. be assumed for the whole of the volatile constituents of coal, that is to say, for all that part which does not burn directly on the grate. This proportion was found above to be 47·4 per cent. of the whole, so that, per lb. of fuel, 3,318 heat units (·474 × 7,000) must disappear in evaporating the volatile carbon, the oxygen, hydrogen and other gases which exist in solid form in coal.

But we have already found that the total heat generated

* Possibly the figure of 7,000 may be too high, except for the carbon and hydrogen compounds. The value for carbon is as above, about 6,000, as evidenced by the difference between the heat produced by burning carbon to its first oxide, and then again to its second oxide. That for hydrogen must be over 7,300, but the values for oxygen and nitrogen are low. Lechatelier determined the molecular specific heats of the elements as $6{\cdot}65 + a\,t$, where a is the constant, and t is the absolute temperature at which the measurement is taken. a was given by him as 0·001 for a considerable number, but he gave values for $a = 0{\cdot}008$, and there is ample proof in Berthelot's great work that at high temperatures the specific heats of some substances may be double and treble the customary figure of 6·65. As the distillation of coal in a furnace is desired to be effected at at least 1,000° or 1,500° F. (say 800° C. to 1,100° C.), the specific heats will be something higher than 6·65. Much, of course, will depend upon the analysis of the coal, but it should be noted that the better the coal, that is, the less oxygen and nitrogen it may contain, the greater is likely to be its latent heat of evaporation, and the denser will be its smoke, for it will be more difficult to consume it perfectly under faulty conditions.

by the 48·84 per cent. of fixed carbon produces 7,150 heat units. The difference between the heat generated by the fixed carbon and that absorbed by the volatile hydro-carbons of these particular Newcastle coals is thus only 3,832 units. This is all the heat that remains available for raising the temperature.

Now we have found an ultimate temperature of 1,584° when not allowing for the latent heat of gasification. We must correct this. It is less in the ratio of 3,832 : 7,150, or 849°. That is to say, if bituminous coal be burned on a grate, and those parts of the coal which volatilise and burn as flame be gathered unburned, the temperature of the whole production of the furnace, including 18 lbs. of air per pound of fuel, would only be 849°, or considerably less than that necessary for ignition.

In the first place, this tells us that it is of the first importance to diminish the supply of air to a minimum. By passing only half the air through the grate and adding the remainder as required to the evolved gases at a subsequent point, we can at once practically secure double the above temperature, or, say, 1,600°, a temperature at which ignition is possible. Moreover, even 9 lbs. of air is 35 per cent. in excess of the allowance necessary to burn the fixed carbon of a pound of bituminous coal, so that it would be liberal practice to pass only half the total air through the grate. Some of the heat developed on the grate is at once radiated to the boiler surfaces; hence my constant contention that furnaces should be lined wholly or partially with refractory material, in order to conserve the necessary temperature.

It must not, again, be overlooked that some of the evolved hydro-carbons do burn on the grate and at the fire surface. In fact, they commence to burn at once and continue to burn to the end so long as conditions are maintained favourable to continuous combustion.

Rankine's estimate of air, as found in ordinary practice, was 25 lbs. per pound of fuel. The so-called chemical minimum is 11½ lbs. I have assumed 18 lbs. as good practice, but as low or lower than 15 lbs. has been recorded by Mr. Michael Longridge.

If, however, we pass 9 lbs. of air through the grate and, say, a further 6 lbs. over the grate in fine streams to assist the combustion of the hydro-carbons, and take care that we do not abstract heat faster than it is generated by the burning gases, we ought to be able to secure perfect combustion with less than 18 lbs. of air per pound of coal. There is no known reason why we should not. The impossibility of smokeless combustion has been widely and influentially urged, but never so much as by those engineers who cram their heating surfaces right upon the fire and never trouble their brains to inquire why it is that a thermometer shows the same continuous reading of 32° F. in a vessel of melting ice with a flame under it until all the ice is melted. A piece of coal, like a piece of ice, is simply so much solidified gas, and absorbs heat greedily while vaporising, and it cannot be burned, like so much solid carbon, but must have length and space in which to mix and combine with the oxygen of the air. The following figures, based on Berthelot's investigations, will be useful in this connection, for they show the enormous differences which exist between matter in its several states. Carbon, existing as it does free in nature in at least three solid allotropic modifications, is a peculiarly interesting example. We do not know it as a liquid or as a gas, except in combination. Its three solid forms of crystalline, graphitic, and amorphous, show by their variations of "latent" heat, how great is the effect of form, even when the various forms affect one state alone. The gaseous state of carbon and the heat necessary to put it into that state are easily argued from the difference of heat disengagement in the two oxidations. As the table shows, the oxidation of 1 lb. of carbon (diamond) produces 3,915 British thermal units when the product is monoxide. The heat disengaged by complete oxidation is 14,146 units. The difference of 10,231 − 3,915 = 6,316 units, and this is, obviously, the heat of vaporisation of the diamond. Similarly, for the amorphous forms of carbon, the first oxidation produces 4,415 units, and the complete oxidation produces 14,647. Here the same difference is 5,817, and the greater heat evolution represents the energy necessary to decrystallise the diamond. Thus we learn that when the diamond crystallised, it evolved heat, and we learn that the difference between graphite and the diamond is less than that beween graphite and amorphous carbon. In fact, graphite is about six-sevenths along the road to becoming diamond.

Heat Generated by the Combustion of 1 lb. of Carbon.

State of carbon.	Product of combustion.	British thermal units per pound.
Diamond	Carbon monoxide ...	3,915
„	„ dioxide ...	14,146
Graphite	„ „ ...	14,222
Amorphous	„ monoxide ...	4,415
„	„ dioxide ...	14,647
Gaseous	„ monoxide ...	10,732
„	„ dioxide ...	20,963
Carbon monoxide ...	„ „ ...	10,231

Metamorphic conversions.		Heat absorbed.
Carbon (diamond) ...	Gas	6,316
„ (graphite) ...	„	6,241
„ (amorphous)	„	5,817
„ (diamond) ...	Carbon (amorphous)	499
„ (diamond) ...	„ (graphite) ...	74·7
„ (graphite) ...	„ (amorphous)	424

Stated briefly, it may be said that about half the weight of a bituminous fuel burns upon the grate itself, and produces half the total heat of combustion; but that owing to the heat of formation of gaseous hydro-carbons, and generally to the vaporisation of solid fuel, which absorbs so much heat, only about one-fourth of the total heat of combustion is sent off from the grate as sensible heat. The remaining three-fourths are developed between the fire surface and the extreme range of combustion. This range varies, of course, with the short or long-flaming quality of the coal. Anthracite coal, which is entirely of solid carbon, and is therefore almost wholly burned upon the grate, will produce a temperature at the surface of the grate very considerably higher than bituminous coal will produce continuously. This is the reason why so much trouble is experienced with the grate bars when anthracite is used. It is evident that every fresh charge of bituminous coal has a very chilling effect upon a fire, and this is especially the case in intermittent firing. The chilling effect of a fresh charge of anthracite is merely that due to the heating of the solid fuel, and is comparatively trivial. The bad effect of anthracite coal upon grate bars is usually attributed to some specially bad quality in the coal itself; but this is probably quite an erroneous idea, the real cause being simply the high temperature, which melts the cast-iron bar. This explanation receives confirmation in the fact that bars go very quickly when they stand above the general surface of the grate, projecting their upper edge into the body of the fire. The thermo-chemical properties of coal do at least afford ample ground for accepting this as the true explanation of the effects of anthracite coals. They also afford the fullest proof of the necessity for special attention being given to the combustion of bituminous fuels. Knowing how very effective the first exposed heating surface has always been found to be, it becomes easy to understand that, in a water-surrounded furnace, so much heat may be abstracted from the fire that the combustion of the gases beyond will be very seriously checked if not entirely prevented.

I am unaware of any previous recognition of these principles in the combustion of coal. It has long seemed to me that fuel combustion was carried out very erroneously. While the cooling effect of distillation of bituminous fuels always presented itself as intensifying the mischievous effects of cold furnace surroundings, the latter had always appeared amply sufficient to account for smoke without seeking further for thermo-chemical reasons. But the persistent refusal of the modern school of boiler men to look the matter of combustion of bituminous fuels squarely in the face has induced further research, and shown me that the question of burning bituminous coals is even more complicated than had appeared. It has also shown me that past practice has been even more irrational and more hopeless

be 7,150 B.Th.U. Now, so far as regards the fire upon the grate, these 7,150 heat units are all we have to work with.

of evaporation, and the denser will be its smoke, for it will be more difficult to consume it perfectly under faulty conditions.

than I had imagined, as well as pointing to a more hopeful future.

The question of combustion is further complicated by the variation of the specific heat of gases at high temperatures. Recognised and worked upon by Bunsen and others, the subject has been most thoroughly investigated by M. Berthelot, to whose great work—"Thermochimie"—it is hardly necessary to say I am so much indebted. That the specific heat of gases does increase with temperature there is now no doubt. At ordinary furnace temperatures the effect is not great, but such as it is, is in the direction of keeping down temperatures below what they would appear to be when calculated on the basis of constant specific heat at all temperatures. This point is only raised here, as it serves to emphasise the fact that furnace temperatures are always lower than ordinary rough calculations make them.

First, only half the coal is burned actually on the grate; secondly, the other half, and all the excess of air, work even to reduce the temperature; thirdly, there is the reducing effect of vaporising half the fuel, and this is simply enormous and has never before been recognised as considerable, if indeed it has been even allowed to suggest itself; fourthly, there are the very active heat absorbing surroundings of water-cooled plates or pipes. All these causes work together, with the further assistance of increment of specific heat, to reduce the products of bituminous coal to a temperature below that at which perfect combustion is possible. The combined action is so powerful that even so-called smokeless Welsh coal will smoke in boilers of the Belleville type.

In any case, even if the effect of vaporising the solid fuel has been over-estimated, the fact remains that it nearly approaches the figures given, and must prejudicially affect the furnace temperature. It teaches us at once the complication involved in burning bituminous coal, and the hopelessness of all those forms of furnace that attempt to extract heat from the fire within a short distance of the fire itself.

REGULATION AND ADJUSTMENT OF ARC LAMPS.*

By M. E. CHESTER, '97, Telephone Engineer with Western Electric Company, Chicago.

The modern arc lamp is a simple mechanical and electrical mechanism, the growth of 25 years. Brush first put his single solenoid differentially-wound lamp on the market in 1875, since which time there have been various combinations of rods, chains, springs, ratchets, cog-wheels, and auxiliary levers for sale. This seems to be the natural tendency in the growth of the design of most apparatus, which is always followed by a plain, simple machine, free from the various auxiliary parts and accomplishing the result in the most direct manner.

The following are the different types of arc lamps in use, each of which may be operated from a direct or alternating-current circuit, using an open or enclosed arc: (1) Constant current series lamps; (2) constant potential lamps used singly across a constant potential circuit; (3) constant potential lamps used with one or more in series across a constant potential circuit. Each of these lamps requires a different method of regulation, depending upon the constant and variable factors of the circuit, and the relative action of one lamp upon another in the same circuit.

The constant current series lamp must necessarily regulate by the variation of its arc voltage. This is accomplished through a high resistance magnet placed in shunt with the arc, so that an increase of voltage across its terminals, due to the consumption of the carbons, will cause the magnet to bring the carbons nearer together, until the limit of the clutch movement is reached; then the carbon will drop and reduce the current in the shunt coil, so that the opposing force, which may be a spring, weight, or series coil, will separate the carbons to their normal positions. This operation is repeated as often as the adjustment of the regulating mechanism will allow. A series coil is necessary to separate the carbons when the current is first turned on; this coil may be independent of the regulating magnet, or it may work in opposition to it, either through a separate magnet, or wound differentially on the same core with the shunt coil, the resultant magnetism increasing or decreasing, depending upon the current in the shunt winding.

The constant-potential lamp used singly across a parallel circuit has become very popular since the introduction of the enclosed arc a few years ago, which allowed the use of a high voltage arc, and increased the life of the carbons. This lamp demands a smooth, uniform, high grade carbon, which will burn uniformly without blackening the globe, and which will fit closely and move freely in the enclosing globe, thus preventing an unnecessary admission of air, which reduces the life of the carbons. The quality of carbons used allows the clutch to operate directly upon the carbon, and not through the medium of the objectionable carbon rod or chain, thus simplifying and reducing the length of the lamp, which fact renders it useful in low-ceiling rooms.

Since the voltage of the circuit is constant, this lamp will regulate by a variation of current, thus requiring a series coil to regulate the feeding, and to strike the arc when the current is turned on. When the voltage is switched on to the lamp, the rush of current through the series coil will cause the carbons to be separated a predetermined distance, depending upon the voltage of the arc. As the carbons burn away the current will reduce, allowing the magnetism to decrease, and the carbons to descend to a point where the current will increase again, and the magnet will draw the carbons farther apart. This operation is continued within the limits of the adjustment of the mechanism.

A direct current lamp used on a 110-volt circuit will require a current of 5 amperes at 75 or 80 volts at the arc, and no change in adjustment will be necessary for not more than a five-volt variation.

A direct-current lamp used on a 220-volt circuit will require a current of 2·5 amperes at 135 volts at the arc. On account of its violet rays this lamp is sometimes objectionable for indoor use, but this fault may be obviated by connecting two 110-volt lamps in series or by using a globe composed of two layers of glass, one of which is clear and the other opalescent. The combination of these two layers of glass acts upon the violet rays and turns them into white light, but with a material loss of intensity.

In the constant potential lamp it is always necessary for its successful operation to have a constant resistance in series with the arc to maintain a constant current, and therefore the same intensity of light. In the constant current series lamp it is necessary to keep a constant voltage at the arc for the same reason; or, in other words, the energy or watts expended in the arc must be constant to obtain a uniform light. The resistance is also necessary to prevent an excess of current on starting up the lamp when the carbons are together. The resistance is not for the purpose of reducing the voltage of the line to that of the arc, as is sometimes supposed, but it is necessary for the successful operation of the lamp as mentioned before. As the carbons burn away, the current will decrease slightly, and requires an increase of voltage to maintain a constant current; this decrease in current will cause a decrease in the drop across the constant resistance, and since the line voltage remains constant, this decrease of voltage across the resistance will cause an increase of voltage across the arc, and therefore increase the current slightly. This will continue until the clutch which holds the carbon is allowed to feed, thus increasing the current enough to energise the series coil, so that it will draw the carbons apart to the proper length of arc as before. Take, for example, the following case of an enclosed arc which burns at 80 volts and 5 amperes on a 110-volt circuit. If the arc burns away so that it requires 81 volts, due to its increased length and resistance, the current will decrease in proportion, and therefore the drop across the constant resistance of 6 ohms will decrease to 29 volts and supply the necessary volts for the arc. In actual operation the amount and rate of variation of voltage will be very small, and the lamp will burn on a variation of voltage from 75 to 85 volts at the arc.

Suppose we put this lamp that requires 80 volts across a 100-volt circuit, which may appear feasible at first sight. As the carbons burn away, the resistance of the arc will increase and will require more voltage to force the current through it; but since there is little or no resistance in series with it, the current will decrease at a very rapid rate and again increase rapidly, due to the shortening of the arc in feeding; this will cause the lamp to chatter and flicker constantly.

Where a 110-volt lamp is used on a 100-volt circuit a part of the resistance should be cut out or short-circuited until the remaining resistance will take up about 25 volts when the current is at five amperes. When the voltage is at 120 more resistance should be inserted, until it takes up about 40 volts at five amperes.

Alternating arc lamps differ from direct current lamps in that while the poles are changing from positive to negative the rate of consumption of the upper and lower carbons is nearly equal, and the distribution of light is nearly the same above the horizontal drawn through the arc, as it is below it; while in the direct-current lamp a large percentage of the light is below the horizontal.

Good results have been obtained with the alternating enclosed arc lamp, allowing the frequency to be increased without objectionable humming, the arc to be maintained at a higher voltage, and an increased life of carbons. Two forms of regulating magnets for alternating lamps are in use, one depending upon the magnetic attraction of the armature, as in the direct-current lamp, and the other upon the repulsion of an aluminium armature. This repulsion type of lamp will work satisfactorily on circuits varying from 90 to 115 volts, and a frequency from 60 to 133 cycles per second, without any change in the adjustment of the regulating mechanism whatever, and the only change required in the lamp to accommodate the particular conditions between these limits is to vary the number of turns on the choke coil in series with the arc. This choke coil answers the same purpose as the resistance does in the case of the direct-current constant-potential lamp.

One of the greatest difficulties with alternating arc lamps is to prevent excessive noise or humming of the lamp parts at high frequencies. This is sometimes due to the enclosing globe not fitting properly.

The constant potential lamp, used in series with one or more lamps on a constant potential circuit, requires an individual regu-

* *The Technograph.*

diamond. Thus we learn that when the diamond crystallised,

lation, and must therefore be shunt controlled as in the constant current series lamp. If they were series controlled, a variation of current in one lamp would affect all the others. In this type of lamp the carbons are held apart by a spring or weight, acting in opposition to a high resistance magnet in shunt with the arc. When the current is turned on, the voltage of the line is sufficient to energise the shunt coils, so that they will bring the carbons together and draw the arc, the method of regulation then being similar to the constant current series lamp, except that all the lamps must be on at once. This method of striking the arc could not be used on a series circuit with all the carbons separated and the shunt coils in series on a constant current machine.

If one lamp of a series draws a longer arc than the others in the same series, more of the resistance should be cut into that lamp, and an equal amount cut out of the other lamp of the same series, if a series of two lamps; and if a series of more than two lamps, the amount cut out must be divided between the other lamps so that the remaining lamps will each burn proportionally higher, while the lamp that has more resistance cut in will burn more.

If one lamp burns with a lower voltage at the arc than the rest of the series, it can be raised by cutting out a part of its resistance and adding the same amount to the other lamp (or lamps, if more than one) of the same series. A dash-pot of some kind seems to be necessary to keep the working parts stable; this may be a separate plunger in air or the tight-fitting, central armature in a single solenoid lamp. When the arc is struck, the carbon rod and those parts connected to it come up with such a force as to have considerable momentum, which tends to carry the carbon farther than intended, and if its progress is arrested suddenly, this momentum will be reversed and tend to send the carbon back, shorten the arc, and cause the carbons to be drawn apart again and repeat the operation as before; consequently the lamp will chatter, varying the current or voltage so as to produce a flickering light.

In installing constant potential lamps, a reliable fuse, which will safely carry the normal current of the lamp, but which will blow at twice this current, should be connected in series with each lamp or series of lamps. This will ensure safety from over-heating of the regulating solenoid of the lamp, in case of a short circuit, or failure of the lamp mechanism to operate properly at any time; it will also serve to protect the mains leading to the lamp from the effects of abnormal current.

The main object in adjusting an arc lamp is to get it to pick up and feed properly at the correct voltage or current.

The system of forces acting in an arc lamp should always be in a balanced state, so that a small change in one will cause a correspondingly small change in the other elements, and consequently cause a delicate and active feed. The forces usually consist of an electro-magnet or magnets, and a spring or gravity. The relative value between the forces is shown by pulling down on the carbon rod where the lamp is burning; this tension will show the difference between the strength of the regulating magnet and the opposing force, and also that the opposing force is greater. If the rod pulls down too hard it shows that the voltage of the arc will have to increase considerably before the strength of the regulating magnet becomes equal to that of the opposing force and allows the lamp to feed. This tension, shown by pulling down the carbon rod, is an indication of the adjustment of the lamp, and one soon learns from experience the voltage at which the lamp will feed. The adjustment should not be too delicate or the lamp will be too unstable, and will not pick up properly every time.

Another indication of the adjustment of an open arc lamp and of the voltage at which it is burning is the shadow on an opalescent globe. If the arc hisses and the shadow is of a muddy colour, the voltage is too low and the length of the arc on picking up should be increased. All open arc lamps will hiss when first feeding, but should not continue to do so. If the shadow is of a blue colour the voltage is too high and the arc should be shortened. The lamp may pick up too high or it may feed too high, the proper voltage being shown by a clear globe with no shadows while the arc is burning.

The shadow should be in the upper part of the globe when the lamp is connected up properly, or, when cutting out the lamp, the upper carbon should be red-hot.

The shadows are sometimes due to the size of the carbon. A smaller carbon will give a steadier light because the arc does not have to travel around so much, but will not last so long.

It sometimes becomes necessary, after lamps have been in use for a considerable length of time, especially when used for street lighting, to clean, repair, and readjust them. After the cleaning and repairing has been done, it is necessary that the lamp be tested and readjusted, as experience shows that whenever even one new part has been put into the lamp without being tested, it has caused trouble, and it is, therefore, always advisable that the lamp should be tested before putting it into use again. A careful examination should be made of all parts to see that the armatures are central with the cores, and that they come down squarely and evenly, and that the carbons are accurately centred. When the top carbon rod is drawn up by hand, the lamps should cut out promptly and not "flash" the generator. In case the arc is very long or causes flashing, look at the contacts, and see that they are clean and make a good square contact; also examine the centring of the armature. The cause of the trouble will usually be found in one of these places. The action of a bad feeding lamp may often be confounded with that of a bad flaming carbon. This can be readily distinguished after a few minutes' observation. The arc of a bad feeding lamp will gradually grow long until it flames, the clutch will let go suddenly, the top carbon will fall until it touches the lower carbon, and then pick up. A bad carbon may burn nicely and feed evenly until a bad spot in the carbon is reached, when the arc will suddenly become long, flame and smoke, due to impurities in the carbon. Instead of dropping, as in the former case, the top carbon will feed to its correct position to the limit of the clutch. The lamps rarely burn as well when first started as afterwards. This is principally due to the fact that the carbons require a little time to burn to the proper shape.

Do not imagine that every time a lamp hisses or flames a little that it is out of adjustment. As a rule, bad working is due to stickiness of the moving parts or to poor carbons. The lamps once properly adjusted and operated with good carbons, should not get out of adjustment, and should be left alone in that respect.

In some forms of enclosed arc lamps the return current passes from the lower carbon to the line by one or two rods of the frame, and the magnetic influence of the current is not balanced, and consequently the arc is blown to one side of the carbons, causing them to burn obliquely and producing unsteadiness of the arc and objectionable shadows. In some forms of lamps the current returns through three side rods, equi-distant from each other. The joint magnetic action of the current flowing though these three rods holds in balance the arc, and the carbons burn evenly.

The consumption of the carbon is due to volatilisation and oxidation of the upper carbon and oxidation of the lower. The rate of consumption of the lower carbon is about one-half that of the upper. This is due to the fact that it is at a higher temperature, and also that it may deposit some of the carbon particles on the lower carbon rod. In the enclosed arc lamp the life of the carbon is longer, since the admission of air is slower, and consequently the oxidation is reduced; while in the open air the consumption is very rapid, due to the unlimited supply of air. In the former two gases are formed—carbon monoxide and carbon dioxide—which, when retained in the inner globe, attain a pressure higher than that of the atmosphere, and therefore prevent a free admission of oxygen. In the open arc the upper carbon burns at the rate of about 1 in. per hour, while in the enclosed arc it burns at the rate of about 1 in. in 20 hours. The life of carbons in alternating lamps is not quite as long as in direct current lamps.

Series arc lamps used on high potential alternating current circuits are now practical, and sometimes require a separate regulator for the system when the number of lamps in the circuit varies.

For a number of lamps operated on a constant potential alternating circuit a system has been perfected in which no regulating device of any kind is necessary outside of the lamp itself. Each lamp is self-regulating. The position of the armature core in the series magnet is depended upon to vary the impedance of the circuit. The lamp operates with 425 actual watts at the arc on a current of 6·6 amperes at about 70 volts. Each lamp of the series is provided with an automatic cut-out, which, upon extinguishing the lamp, introduces a choke coil into the circuit consuming about 35 watts of energy. When a lamp is thus automatically cut out the remaining lamps of the series are not interfered with in any way.

A condenser connected around an alternating lamp may improve the regulation of the lamp and increase the power factor of the system. A suitable condenser for this purpose has not yet been found. Existing types are too large and expensive for practical use.

CORRESPONDENCE.

Central Station Man's Grievance.

It was not my intention to write again on this subject, but since it seems that my letter has caused some little misapprehension on a few points, I would beg leave to clear them up, as, though perhaps not bearing directly upon the subject under discussion, there should be no doubt about such points in an engineering magazine.

To begin with, there seems to be a decided difference of opinion as to what a marine engineer is, and he seems to have been to some extent confounded with a marine fitter.

I think that a marine engineer in the merchant service is a skilled mechanic, who, after having served his apprenticeship in some engine works (not necessarily marine) and spent the necessary time at sea, has passed the B. of T. examination for a second class certificate, but I am quite open to receive a better definition.

At the same time, however, the term "engineer" is applied commonly to many mechanics serving afloat who have not so qualified, and it is with these latter that the ordinary naval artificer of the same age is quite on a level, being drawn from the same class of man and having worked in the same workshop.

Of the excellence of the professional knowledge of the naval artificer, especially of the senior ones, I have personal knowledge, and should the marine engineer who is obtaining the position of charge engineer at a central station be a better man, then all my remarks in my last letter hold doubly good, and our "Enlightened Student" will find in him a most formidable competitor. I quite agree with

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* *The Technograph.*

fitting properly.

The constant potential lamp, used in series with one or more lamps on a constant potential circuit, requires an individual regu-

"San Marino" that there are marine engineers in the Mercantile Marine who, after a short experience in the working and routine of a battleship, would be competent to take charge of the machinery of one, but it would be necessary for them to first go through a special course of torpedo and hydraulic instruction. I am sorry that "San Marino" thinks I am hard on marine engineers, for such is not my intention at all. Another point I heartily agree on, is that should a marine engineer desire to become an electrical engineer, if he wishes *to obtain a responsible position, and, moreover, become fit for one*, he must in some way or another obtain the necessary practical and theoretical knowledge. As to how he obtains his knowledge it does not matter so long as he does obtain it. Whether he obtains it by attending some institution or by accepting an inferior position for the time being and "picking up" his knowledge as opportunities occur, it is of no consequence.

Should electrical students and marine engineers find themselves in the same station, it will be to the advantage of both to work harmoniously together, as each will then gain most valuable advice and assistance from the other.

If the student is so infinitely superior, what need has he to fear the marine engineer, as in the end he must beat him and obtain the superior position. If, on the other hand, the marine engineer is a smart man and quickly picks up the "run" of the electrical equipment, he will beat the student.

In either case both student and marine engineer stand on their own merits, and the better man need not fear the other, as he will certainly displace him. As to which is the better man for any particular post, it is for the chief engineer of the station to judge, and not for the subordinate, even though he be an enlightened student.

Turning to the latter part of Alec. Gavan Inrig's letter, I will pass over the remarks about "very young," "swelled head," &c., because they in no way affect a discussion. If Alec. Gavan Inrig is a mercantile marine engineer, I can quite pardon his natural pride in his own profession, and am sorry if I inadvertently expressed an opinion differing from his, but I hardly think he can be a seaman, for it is not part of the courteous nature of a seaman to jump down the first person's throat who differs from him. I do not wish him to misunderstand anything I said, however. I would first say that an artificer in the Navy is not an engineer officer, although in a very large number of cases he actually carries out the duties of one, owing to the scarcity of engineer officers in the Navy. The Admiralty have, however, created the warrant rank of artificer engineer, to which the senior artificers are admitted on passing a competitive examination. These warrant officers hold such important posts as chief engineer of gunboats, sloops, and torpedo destroyers of large power, and may therefore be fairly classed as the equals of the chief engineer of cargo or the smaller passenger vessels of the same horse-power, who, I take it, certainly come well within the meaning of marine engineer. Should this statement be doubted, I would refer any reader to the current number of the Navy List.

Further, I do not make the statement that every engineer officer in the Navy is better than every engineer in the merchant service. Such a sweeping assertion would be unfair and untrue, but I do and will maintain that the ordinary naval engineer is far ahead of the merchant service engineer for very obvious reasons.

1. He is drawn from a far superior social and educated class of man.

2. He receives at least five years, very often six, and sometimes eight years of the very best *combined* theoretical and practical training at Keyham and Greenwich. This training includes not only marine engineering proper, but also thorough instruction in air compressing, hydraulic, electric light and torpedo machinery. The merchant service engineer through no fault of his own can obtain no such training.

3. After going to sea his experience is far wider, for he is continually changing from the heavy machinery of battleship and cruiser to the light fast-running machinery of a destroyer and back again to old types of machinery, &c., and his experience of all the varying types of water-tube boilers is perforce far ahead of his brother in the mercantile marine, who is practically always in charge of machines of one unvarying type.

This is a digression I am aware, but owing to the challenge of Alec. Gavan Inrig, I may perhaps be excused for substantiating my statement, which I do in a perfectly friendly spirit. "H. T. R." is quite wrong, however, when he states that "several hundred" assistant engineers in the R.N.R. have been drafted into the R.N.

Assistant engineers who have not passed through Keyham, have from time to time been admitted into the service, and though some of them are of the very best, the general opinion of all the higher engineer officers of the Fleet is that it was a great mistake, and not conducive to efficient engine-room complements. These assistant engineers, however, have in no case entered from the Mercantile Marine, the very age clause would prevent that. "H. T. R." must, moreover, be quite ignorant of naval affairs if he takes the First Lord of the Admiralty's opinion about any naval engineering matter without a very large pinch of salt. Returning to our subject, however, I have had this statement made to me by a gentleman who is the chief engineer of one of our largest and most important central stations, and who is an undoubted authority on these matters, and it is that he wants to fill all his posts with "Mechanical engineers who have a knowledge of electricity." This will, perhaps, serve to concentrate ideas on this subject. Let it be noted that he must *first* be a mechanical engineer.

I consider our "Enlightened Student," by his one little remark at the end of the "Correspondence" column, has completely given himself away. Here we have one passing as a *student* publicly announcing his opinion that many sound and common sense letters appearing in a scientific paper of large circulation are nothing but drivel. One is inclined to suspect that this is the light in which he views other things, including, perhaps, the excellent advice of some marine engineer in a central station. Electrical engineering is a *branch* of mechanical engineering, and no "student" of the former can neglect to obtain any knowledge of the latter which may come his way, however enlightened he may be.

C. J. Greene.

The replies in your issue of the 16th inst. have wandered a little from the main point, viz., "Why is a marine engineer incompetent to become a shift engineer?"

As "An Enlightened Student" points out, this usurpation is on the increase, but surely, Sir, our resident engineers know best what class of men they want as their assistants. They certainly are the best able to judge, and as they are the men that have to make a station pay, they naturally get the most suitable aid to gain this point. Without a doubt this has to be chiefly done in the steam plant, and I say that the marine man of experience can do this better than a student, who has had no experience in steam raising and generating energy.

Mr. C. J. Greene, I think, blows his horn at the wrong end; it is presumption on his part to say that "an engineer officer in the Navy is a *far better man* than an engineer in the merchant service." My opinion is that it is "brains" that go to make the true engineer, and not necessarily "an engineer officer in the Navy."

The gentleman who signs himself "One of the Younger Members" seems to have got his hair ruffled. He also appears to have a thorough knowledge of all things, younger members (calls them students), marine engineers and their ways, and station assistants, but I don't believe that one marine man in a hundred would go on his knees for information from any student, as he says they do for about "three months after their arrival in the station," and if "the younger member" in question looks at my last week's letter again, may I point out that the words "large majority" are credited as having a definite meaning in the English language.

Of course, everyone has a right to his own opinion, and mine, based on experience, that in the marine man you invariably get the better shift engineer, is unchanged.

Another point a few of your correspondents touched, and that is the small salaries accepted by marine men on giving up the sea. I beg to state that they are not alone in that respect.

Very often, in the "Situations Vacant" columns, we find

become long, flame and smoke, due to impurities in the carbon. Instead of dropping, as in the former case, the top carbon will feed

doubly good, and our "Enlightened Student" will find in him a most formidable competitor. I quite agree with

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shift engineers wanted at a salary of from 25s. to 30s. per week: we know a good many are filled by students, and several marine friends of the writer have secured shift engineer's billets at £104 per annum.

J. D. A.

Wallsend, *August 21st.*

I sympathise with "An Enlightened Student's" complaint in your last issue, *re* lack of argument, and feel sorry that what might be a useful discussion should be little more than calling each other names. What is really wanted is proof as to which class of men is most fitted for the position under discussion.

The first thing to consider is what is required of a charge engineer; stations for the production of electricity are mostly modern, and consequently we find them full of the most modern machinery of all descriptions. First, the boilers and the plant connected with them, numerous and often complicated; next the engines, with their intricate governors and cut-off gears, and finally the generators and switchboards.

The man who has to take charge of all this machinery must be one capable of observing the signs of coming danger so that he can avert it before damage is done, or be prepared to meet it so that it shall cause the least, if any, delay. He must have the practical knowledge that will enable him to see that everything is worked to its best advantage, and that neither coal nor steam is wasted; he should also be able when necessary to use any tools, and do any repairs that an emergency may require.

I think it will be admitted that accidents are far more frequent amongst the working machinery and boilers, than with the generators or switchboards, and that therefore knowledge of those parts is paramount; this knowledge is not to be gained by a few months spent in strolling around workshops, but can only be acquired by years of actual work amongst both boilers and engines, in building and running, proof of which is shown by the B. of T. requirements for sea-going engineers. Under these conditions, the engineer is certainly a better man than the student, who has theory but no practice, and the engineer with a slight electrical knowledge is far better than the student with a slight practical knowledge. It is also a matter of fact that it is found much easier to teach the engineer the necessary electrical knowledge than the student the needed practical knowledge.

If marine engineers are displacing the students, it is not from a philanthropic reason, but because they are found the better men, and as such deserve the position; the remedy for the students is too obvious to need telling.

In conclusion, I may say that, although the B. of T. consider me a first class "engineer," if it is any satisfaction to "An Enlightened Student," I am not ashamed to subscribe myself

A Marine Fitter.

I have read with some amusement your correspondent, Mr. Snell's, letter in last week's Review *re* "marine fitter." In the first place, I think it is quite out of form of Mr. Snell to question a man's enlightenment whom he does not know, simply because he does not see eye to eye on this question with himself. The "Enlightened Student" was, as far as I can see, not speaking of his enlightenment, but of his chances of losing appointments through the appointment of "marine fitters." Then as to charge engineers at Sunderland, such do not exist, that is, in the sense that charge engineers are generally understood. The Sunderland charge engineers are fitter drivers, who do the driving on the watch they are on and look after the stokers, and know nothing at all about the electrical portion of the work. A charge electrician is always present on heavy shift, and also a switchboard attendant; these men give directions when a machine is going on or coming off, and have to tackle any defects in the electrical part of the plant. They are not mentioned in Mr. Snell's letter, for reasons which will at once be apparent to anyone who reads the letter carefully. They are *not* marine men.

Mr. Snell not being a marine engineer himself, has no motive for supporting them, except that he is now in a position to ignore usurpers, but had he been asked the same question before he came to Sunderland, say, when he was an assistant himself at St. Pancras, I think he would have had a different answer to the above question.

No one ever thought or suggested that a student straight from college should be put in charge of a station; it would not be fair to more advanced students or even marine fitters. But the student with five years' practical experience and one or two stations behind him is a much superior man to any of Mr. Snell's marine fitters, whom he would no sooner think of leaving in *entire* charge of switchboard, battery, dynamos and engines than flying; a charge engineer should be able to take charge of all plant and mains, and, in fact, tackle anything affecting the system.

The system referred to by Mr. Snell as being in existence at Sunderland *re* students is calculated to make the profession too cheap and create a larger supply than there is a demand for, besides making the Sunderland station into an experimental shop for self-opinionated youths from local firms, who, having just entered the profession, and got put at once into a station, forget what is expected of them.

The best way I know of for ensuring success, though not the most honest, is for your father to be chairman of the committee you work for, like I heard of someone doing once. Then if you are an enlightened student (*sic*) or a marine fitter (*sic*) success is yours.

v of Fair Play.

Wanted—Fire-proof Insulating Material.

I am looking for a fire-proof insulating material which can be either turned up or moulded into any required shape, and which will lose neither its electrical nor mechanical properties if successively heated up to a red heat and allowed to cool again for an unlimited number of times.

The material in question should also be capable of standing considerable knocking about without breaking.

I should be glad to know if any of your readers have come across such a material.

K. E.

[This is exactly what thousands want to come across; we wish they could!—Eds. Elec. Rev.]

COMPENSATION OF ALTERNATORS FOR CIRCUITS OF VARYING POWER FACTORS.

By SYDNEY WOODFIELD.

At the present time polyphase machinery is coming more and more into vogue for power and lighting, and for both combined; and it therefore becomes a matter of considerable importance to have some means by which the terminal potential of an alternator may be automatically controlled for all values of the load and for all values of the power factor of the load. The automatic regulation must be obtained with as little complication as possible, for the smaller the number of working parts, so much the better for simplicity and reliability. If the field excitation of any machine be kept constant, the drop of potential between no load and full load (rated ampere output) is termed the inherent regulation of the machine; obviously this value will depend on the power factor of the external load.

The E.M.F. at the terminals of an alternator on load depends upon the resultant effect of (1) the induced E.M.F., (2) the inductance E.M.F. of the armature, and (3) the ohmic drop in the armature conductors. The inductance E.M.F. of the armature is due to the current in the armature conductors which sets up a flux which does not link with the field spools.

Leaving out the ohmic drop in the armature, which for a given frequency is proportional to the current, we have the armature reaction and the armature inductance (these are usually classed together and termed armature reaction or

who is practically always in charge of machines of one unvarying type.

respect.

Very often, in the "Situations Vacant" columns, we find

synchronous reactance), both of which in a generator working on an inductive load tend to demagnetise the fields, thus lowering the terminal potential; or if the machine is working on a negative inductance, *i.e.*, a capacity or its equivalent, tend to strengthen the fields, giving a rise of potential on the alternator terminals.

In modern machines the armature inductance and strength (ampere-turns on armature per pole) are maintained low by using a distributed winding with as few turns as is compatible with other requirements, whilst the induction is run at as high a density as is permissible. In any machine, therefore, we have to compensate for the drop of potential due to the armature resistance, the armature inductance, and the armature reaction.

It must be borne in mind that the methods given below do not take into account any unbalanced condition, as all phases are compounded alike. This, however, is no real difficulty, since in a lighting scheme the lights would be pretty well balanced, and in a combined system the motors would take their current mostly from the phase having the highest potential, thus tending toward equalisation.

The usual method of compensating (leaving out hand regulation) has been by compounding the alternator, just in a similar fashion to that used in a direct current generator, the alternator series winding receiving unidirectional currents from a rectifying commutator having as many segments as there are poles on the alternator. This method serves well as long as the potential and current are in phase, but this condition is rarely met with, since partially loaded transformers and non-synchronous motors produce lagging currents, which, as explained above, tend to demagnetise the generator fields, thus requiring a larger field excitation to maintain constant potential at the terminals. There would also be the necessity of shifting the brushes to get the position of minimum sparking as the power factor of the external load varied.

In two-phase systems the above method is also applicable, a series transformer being used, having two primaries placed in two legs of the machine; the secondary potential is therefore due to the combined effects of the two primary currents, and is $\sqrt{2}$ times as great as the effect due to the current in one leg only, assuming conditions balanced, the phase being 45°, or midway between the two. If the load becomes unbalanced the effect increases, though not

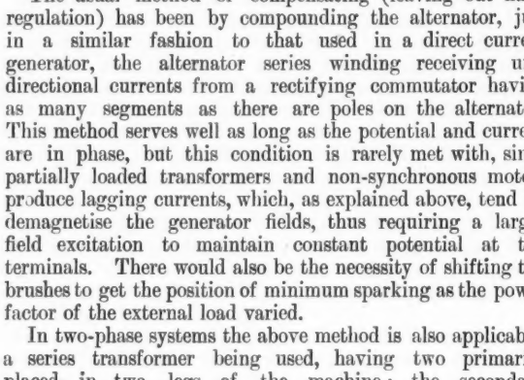


Fig. 1.

proportionally, and the phase is altered, coming more nearly into phase with the larger load, thus requiring a readjustment of the brushes in order to get the point of minimum sparking.

In a three-phase system the series transformer would require three primaries, one being reversed with regard to the other two. This will then make the phases 60° apart, and the resulting effect will be the vector sum of these. If the load is unbalanced the resultant is not proportional to the load, although for all practical purposes it may be taken as so. Here again, however, the brushes would require to be shifted.

To overcome the above difficulties the General Electric Company, of Schenectady, have devised a machine for automatically compounding for all values of inductive and non-inductive loads, without any external arrangement whatsoever. The machines so far designed are of the revolving field belt-driven type, the shaft of the alternator carrying, in addition to the revolving field, the armature of the exciter, the field structure of the exciter being mounted in the alternator armature ring. The exciter has exactly the same number of poles as the alternator, and since both run at the same speed, the two operate in synchronous relation. In addition to the slip rings for the alternator field the shaft also carries in this case (three phase) three slip rings which are connected to three places 120° (electrical) apart per pair of poles of the exciter armature, just as in a three-phase rotary converter.

Fig. 1 shows the connections of the machine, a bipolar exciter being shown for clearness. Between the main high tension bus bars and the armature are inserted series transformers, the secondaries being connected to three slip rings of the exciter armature, the exciter brushes being directly connected to the alternator field winding, and the exciter field, which is shunt wound, receiving current through a field rheostat from the exciter armature. It will be seen that all parts which are exposed carry currents at a very low E.M.F., usually under 75 volts, and can therefore be handled with perfect safety, and at the same time the machine is of the simplest nature, and there is but little chance of its getting out of order.

The alternating current is not rectified as is usually done, and there is nothing which should give trouble through sparking on the commutator. The action of the machine

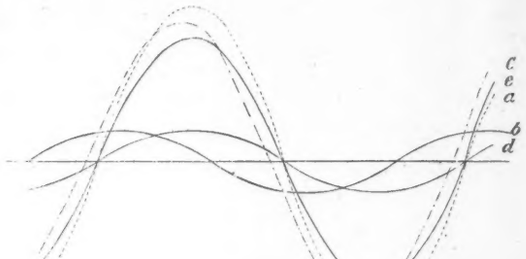


Fig. 2.

is extremely simple; on non-inductive loads with increasing current from the alternator the current through the exciter armature also increases, thereby strengthening the exciter field and likewise that of the alternator.

If the current lags, however, the action is just as simple, as a reference to fig. 2 will show. Curve *e* represents the magnetising effect of the exciter shunt field; curve *b* represents the effect of the current in the exciter armature which, it will be noticed, leads the effect due to the shunt field winding by nearly a quarter period. Curve *c* gives the combined effect of *e* and *b* added together when there is no inductance in the external load. If, however, the alternator is working on an inductive load, curve *b* lags more and more as the inductivity increases towards curve *e*, and the maximum effect is so arranged that it comes in the centre of the pole faces, as shown by the curve *d*.

Assuming *e* as constant, which is not strictly correct, we get curve *a* as the combined effect of *e* and *d*; hence it will be seen that the field of the alternator is strengthened as the power factor diminishes. If, however, the current leads, curve *b* will come more and more into opposition with curve *e*, and will therefore weaken it, thus lowering the terminal potential. In the above case we have assumed that the polarities induced in the exciter armature are of opposite sign to the adjacent field poles, but this need not necessarily be so. If they are of like sign, the regulation will be due to the differential action; but for constant potential work the former method is advisable.

Regarding the operation of these machines, Mr. H. G. Reist, of the General Electric Company, states that he has seen a 50-H.P. induction motor started from a 75-KW. generator, with a drop of potential just sufficient to fluctuate the

They are *not* marine men.

Mr. Snell not being a marine engineer himself, has no

armature reaction and the armature inductance (these are usually classed together and termed armature reaction or

voltmeter needle, and this lasted about half a second, the variation on the lights being only detected by close observation. He further states that at the same time a drop in the speed was noted on the tachometer, so that the drop of potential was due to the decreased speed.

THE GENERATION AND TRANSMISSION OF ELECTRIC ENERGY AT AND FROM COAL PIT CENTRES.

By B. H. THWAITE, C.E.

(*Continued from page* 224.)

The regulation of high-pressure currents (owing to the magnitude of the initial potential) is within easily established control. The economic advantage of establishing the maximum practicable pressures is already generally recognised.

The amount of the conductor metal (copper) required to permit the transmission of electric energy for a defined distance and at a predetermined degree of efficiency will vary inversely as the square of the voltage—in other words, for a predetermined percentage terminal loss in any long-distance transmission project the doubling of the line pressure will be equivalent to the division of the weight of copper required by four.

Of course, no arbitrary economic formula is exactly applicable, because the rate of appreciation, or the converse depreciation, of the market value of the metal used must be taken into consideration.*

Insulation of the Line.—Experience shows that with all so far known methods of line insulation, it is practically useless to attempt the insulation of a line transmitting energy at pressures exceeding 5,000 volts. Consequently, the use of bare conductors is unavoidable. Dielectric effects have been greatly magnified. Experiments point to an existing state of saturation of the dielectric.†

Line Holders or Insulators. — The material most thoroughly suitable for lineholders, or insulators, for high pressure electric transmission purposes is porcelain, so highly vitrified in the kiln that its fracture exhibits the characteristic brilliance of intense vitrification.

A highly vitrified porcelain insulator will not only resist the incursion or absorption of moisture, but it is so satisfactorily non-conductive as to be free from liability to electrical non-puncturing effects; and this source of electrical leakage is thus eliminated.

The best physical form of insulator is that which, whilst providing the least degree of surface for the deposition of the water of condensation, shall nevertheless provide adequate line-holding strength. The petticoat-form is considered, far away, the most suitable.

Line insulators have been so designed as to provide an annular oil-containing trough; the difficulty in this design is the prevention of deposited dust or water from interfering with the insulating properties of the oil.

With insulators made of highly vitrified porcelain, there should be no difficulty in transmitting electrical energy at pressures equivalent to 20,000 volts.

In drafting the specification for the line, the exact nominal gauge should be insisted upon. The margin of conductive inefficiency below the standard should never be permitted to exceed 5 per cent. Absolute freedom from oxide scales, flaws, and other imperfections due to careless rolling and wire drawing of the conductor metal, should be specified conditions. The tensile strength should also be defined.

The subjoined table shows the comparative values in terms of conductivity and strength, of common conductors.

Table Showing the Comparative Conductivity and Cross-section of Common Conductors.

Conductor metal.	Per cent. conductivity. A.	Tensile strength. Tons per square inch. B.	A × B.
Copper, high commercial purity, unhardened	98	5·6	548
Good hard-drawn copper ...	97	24·5	2,376
Silicon-bronze	75	38	2,850
Phosphor-bronze	26	44·6	1,159
Iron wire, annealed	14	24	336
Steel wire, high carbon	11	58	638

Owing to the low conductivity of silicon-bronze, and except for positions where tensile strength is of supreme importance, column A × B leaves no doubt as to the advisability of specifying good hard-drawn metal as the conductor *par excellence* for general high pressure electric long-distance transmission work.

The stresses to which a conductor line is liable to be subjected are rather more complex than one might casually imagine. There are :—

1. The strains due to its own weight, and tending to produce the catenary curve and the twisting and torsion this may involve.
2. The strains necessary to remove this curve-forming effect by establishing with absolute tension a horizontal direction of the conductor line.
3. The torsional effect of twisting the wire under its tensional condition.
4. And in addition, the stresses set up by wind currents—stresses, of course, that are proportionate to the superficial area of the line exposed.
5. The weight addition of accumulations of snow, ice, and dust.

In order to annul the effect of induction, the line may advantageously be transposed every 10 or 15 poles along the line, and the sub-division of the line is preferable to bunching the line wires together. For very special trunk transmission lines, it may be advisable to duplicate part of the line with one wire, arranged so as to be interchangeable with any of those constituting the normal conductor lines.

Diagram fig. 1, shows the serious leakage by brush discharges, when the line pressure exceeds 25,000 volts. This effect will probably limit, with naked conductors, the degree of line pressure at present economically possible.

Unlike electric aerial traction conductors, the lines for the transmission of electric power are not subjected to the disturbing and frictional influences of a moving contact trolley, and there is not the slightest reason why a conductor of the highest electrical pressures should not be erected, that offers as little danger as does any other engineering agent in every day use, and at the worst involving a mere fraction of the danger to life, of any locomotive railway system.

If the line poles and their erection are structurally adequate, no possible climatic effects can involve the collapse of the line.

Local Distributing Lines.—The three-wire star or mesh system is very popular. This combination circuit reduces the proportion of weight of copper required for a predetermined loss of energy, a reduction of 25 per cent. of weight of copper being secured for the same capacity and line pressure as compared with a two-phase system, having two wires per phase. The system of distribution employing a neutral wire connected to the neutral point of the three-phase windings is recommended; the lamps

* It will be found, assuming equal rates of depreciation and a determined rate of interest (for the transmission of a specified power at the terminal end of a given length of line) a comparison drawn between employing a large weight of copper in the line, and employing transformers and a high pressure, for a length of six miles of transmission; that a 3,000-volt pressure line and one at a pressure of 10,000 volts (involving the use of transformers to increase and reduce the line pressure) *shows that the cost of both systems will be approximately equal.*

† Dielectric effects will, of course, be a function of the ratio of the diameter to the circumference of a conductor, and the proportionate effect therefore rapidly falls with increase of cross-sectional area.

To overcome the above difficulties the General Electric Company, of Schenectady, have devised a machine for

(fig. 2) are connected to the neutral wire and the several main lines. This arrangement is very simple and economic.

Precautions against the Effects of Lightning.—Lightning effects constitute one, if not the greatest, enemy to the maintenance of high-pressure line structural and trans-

Telluride line, 40,000 volts pressure. Diagram from Dr. Bell's work, "Electric Transmission of Power" (page 489).

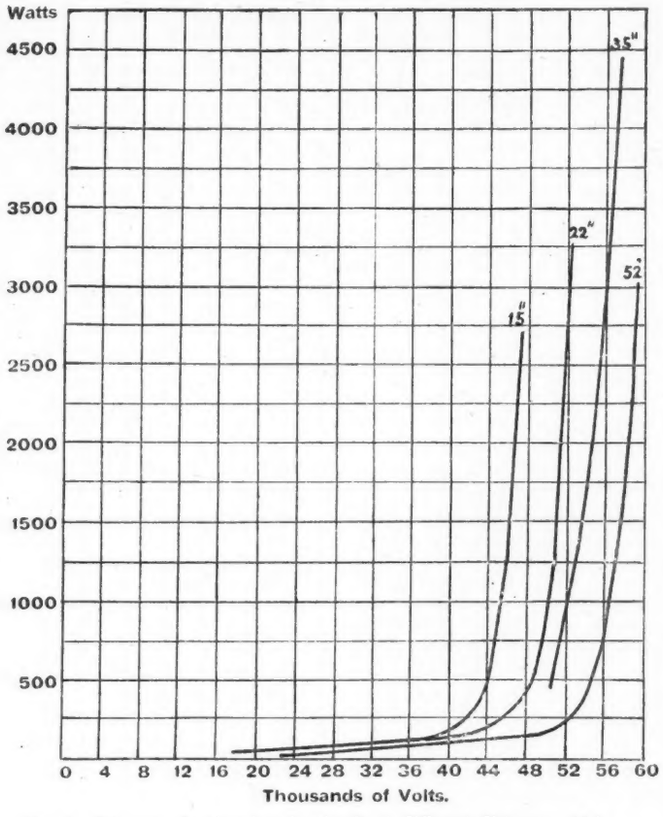


Fig. 1.—Diagram showing loss in circuit at different distances—15 in., 22 in., 35 in., and 52 in. apart. (Frequency, 60; slotted armature.)

mission efficiency, and although no great disasters have so far occurred, nevertheless it has been found advisable to guard against lightning contingencies. Here is an example of what is likely to occur if proper precautions are not adopted.

In the early Genoese installation of 1893 (continuous current) a lightning current struck the transmission line,

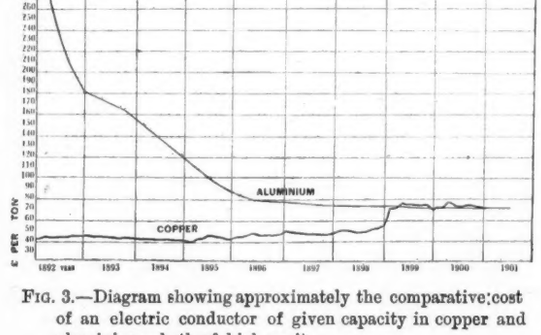


Fig. 3.—Diagram showing approximately the comparative cost of an electric conductor of given capacity in copper and aluminium—both of high purity.

and finding its way along the earth to the electrical machines, it seriously damaged the armatures. The precaution usually adopted is the utilisation of the spark-gap principle located between the line and a grounded conductor.

In order to prevent the machine-generated electrical energy from earthing in the trail of the ground-flow of the lightning energy, it is an excellent plan to locate several spark-gap arresters on the line, and associate each of them with an inductance coil. The arresters need not be used in a manner that will provoke a discharge, and they should be located in easily accessible positions. Another method of attracting the lightning from the line wires is the employment of barbed fence wire stretched from the top of the poles, and grounded at intervals of four or five poles, and as often as the climatic conditions require.

The Conductor Metal.—The author demonstrated in 1892 that in any trunk line scheme of electrical transmission, if the conducting metal is of copper, the capital

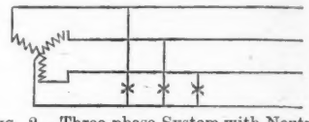


Fig. 2.—Three-phase System with Neutral Wire.

expenditure necessary for this portion of the work should be treated as financially distinct from the rest.

It was then suggested that the capital required for the trunk line should be obtained by the issue of mortgage debentures bearing the rate of $3\frac{3}{16}$ per cent.

The question of defining the character of the risk of expenditure in copper has become most interesting, and but for the incursion into the field of commercially possible use of its rival, aluminium (curiously enough one of the products of electricity), the serious appreciation of the value of copper in recent years might have retarded, in some degree, the growth of long-distance electric applications.

For instance, had the copper for the author's 1892 pioneer project been purchased at the current price of the metal at that time, it would have cost, with copper at £45 a ton, about £100,000; whereas, at the present price of copper, over £80 a ton, it would have cost no less than £180,000, representing an appreciation of £80,000.

Fortunately, electricity itself has provided a limit to the appreciating value of copper for electric conductor purposes, by permitting aluminium to be produced at a price which the graphic diagram, fig. 3, shows to be even now lower for a given conductivity factor than copper itself.

Here are some disadvantages that militate against the use of aluminium. For example, it offers more surface to the effect of wind currents. There is greater difficulty in making satisfactory joints, and it suffers in some measure, not as yet accurately defined, to a greater degree than copper when exposed to the atmosphere of industrial centres.

Nevertheless, the increasing cheapness of this beautiful metal should and will constitute a check to the rise in the price of copper. It will, no doubt, be realised that ordinary telegraph transmission arrangements are quite unsuitable for long-distance high pressure electric energy applications.

(*To be continued.*)

Band Contest.—The brass band in connection with Messrs. Ferranti's Works, Polytechnic Club and Institute, Hollinwood, were recently successful in bringing off the second prize, £40, out of 16 competing bands (including the famous Besses-o'-th'-Barn Band) at the brass band contest at Kirkcaldy, Scotland. The test piece was "Shakespeare's Songs." Locally the result was received with much enthusiasm, and great praise is credited to the members of the band and Mr. A. Owen, the tutor and conductor.

portionate effect therefore rapidly falls with increase of cross-sectional area.

the three-phase windings is recommended; the lamps

THE ELECTRICAL ENGINEERS IN SOUTH AFRICA, AUGUST, 1901.

Where employed.	Nature of work.	N.C.O. or Sapper in charge is named first.
Headquarters ...	Commanding ...	Major A. Bain.
	Regtl. Sergt. Major	S.M. J. Gunn, R.E.
	Pay Sergt.	Sergt. W. McLeod.
	Storeman	Sap. Boult.
	Transvaal.	
Johannesburg ...	Officers	Capt. O'Shaughnessy. Lieuts. Pearce and Rich.
	Fort and barrack installation ...	Sergt. Marshall, Saps. Solomon and Hawkins.
	No. 6 Genl. Hospt.	Sap. Bigge.
	Supt. of electric lighting of buildings occupied by military.	Corp. Hamilton.
Belgravia and No. 13 Gen. Hospital	Searchlight installation	2nd Corp. Clarke, Saps. Hebden, Hobel, Collins, Squire.
Forest Hill ...	Searchlight ...	Saps. Jones, Portway, Cameron.
Crown Reef ...	Do. ...	Saps. Price, Linck, Coleman, Smith.
Springs	Do. ...	2nd Corp. Bell, Saps. Bayley, Cornelius, Delle, Gana.
Klerksdorp ...	Do. ...	Corps. Shaw, Saps. Kelly, White, Crowder.
Randfontein ...	Do. ...	Saps. Lewis, Cockburn.
Krugersdorp ...	Do. ...	Corp. Rogers, Sap. Padmore.
	(2) Hospl. Instn. ...	Sap. Amos.
	(3) Staff Offices do.	Sap. Edmunds.
Heidelberg ...	Searchlight ...	Sergt. Peart, Saps. Hedgecox and Peck.
Eden Kop ...	Do.	Corp. Dobson, Saps. Rumble, Bartlett.
Standerton ...	Installation, lighting hospital and railway station and bridge.	Sergt. Davis, Saps. Beatty, North and Gayford.
Pretoria	(1) Barrack installation	Sergt. Holmes, Saps. Francis, Bryant, Dallison, Gentle and McGregor.
	(2) Traction engines	Lance-Corp. Durling, Saps. Alcock, Middleton,
	(3) Fort installations	Lance-Corp. Botting and four sappers when available.
	Orange River Colony.	
	Officers	Capt. the Hon. R. C. Craven, Lieut. Leaf.
Bloemfontein ...	Hospital installation	Corp. Thorpe, Sap. Stark.
Kroonstad ...	Do.	Being installed
Norvals-Pont ...	(2) Bridge defence	Corp. Liddle, Saps. White, Lynn, Jones, Gallimore.
Bethulie	Do.	Saps. Porte, Harrington.
Vereeniging ...	Do.	Corp. Welling, Sap. Webb-Bowen.
	Cape Colony.—N.C.O. in Charge, C.S.M. J. H. Field.	
Simon's Bay ...	Boer prisoners' camp installation	Lance-Corp. Haswell and four sappers.
Wynberg	Hospital installation	Sap. Hickling.
Green Point ...	Boer prisoners' camp installation	Saps. Harris and Hunt.

Sergeants J. Holmes and Brander, Corporals Devonshire and Holliday, Second Corporals Bertram and Coxon, and Sappers not enumerated above, are employed installing new lights or on necessary camp routine.

All the foregoing installations, with few exceptions, have been put in by the electrical engineers.

It is interesting to note that this detachment has been remarkably free from sickness and casualties; the health of the men has been capital; they have plenty of work to do, of a varied nature, and also instructive; the letters that arrive are very cheerful, and altogether they seem to be having quite as good, if not a better, time than the first South African contingent had.

C. T. Ruse, Acting Sergeant-Major.
By request of the O.C.E.E.R.E.V.

Headquarters, Regency Street, Westminster.
August 28th, 1901.

UTILISING THE SUN'S ENERGY.

Prof. Thurston discourses this month in *Cassier's Magazine* upon the problem of utilising the sun's energy. He points out that in spite of the enormous deposits of coal remaining untouched in other sections of the globe, within a few generations, at most, some other energy than that of combustion of fossil fuel must be relied upon to do the work of the civilised world.

He considers that water power, which is the next most important source of energy to coal, will do much for us, and quotes figures which go to show that the energy capable of use in the area drained by the Mississippi River for instance, may be taken at about a quarter of a million horse-power per square mile. In the next few lines, however, Prof. Thurston points out that such figures are of little value, and this is certainly correct. It is obvious that the available water-power must be calculated from the minimum volume falling under easily utilisable heads. A fall of 6 in. per mile, as in the case of the Mississippi (with the exception of the three small water falls), is of no use whatever.

Prof. Thurston disposes of wind-power and tidal-power after very few remarks, and devotes himself principally to the consideration of the possibility of converting the heat of the sun into mechanical energy by some direct means.

He refers to John Ericsson's contributions to the Centenary Exhibition in 1876, and the figures quoted are certainly interesting. It would appear that with Mr. Ericsson's concentration apparatus, during nine hours per day, an average of fully 3·5 units of heat per minute can be extracted for each square foot of area presented perpendicularly to the sun's rays in all latitudes between the equator and 45° of latitude. Theoretically, this works out to 8·2 H.P. for an area of 100 ft. It appears that there is a rainless region extending from the North-West Coast of Africa to Mongolia, 9,000 miles in length, and nearly 1,000 miles wide. Besides the North African deserts, this region includes the southern coast of the Mediterranean, east of the Gulf of Cabes, Upper Egypt, the eastern and part of the western coast of the Red Sea, part of Syria, the eastern part of the countries watered by the Euphrates and Tigris, Eastern Arabia, the greater part of Persia, the extreme western part of China, and lastly, Mongolia.

In the western hemisphere, Lower California, the tableland of Mexico and Guatemala, and the West Coast of South America, suffer from continuous intense radiant heat for a distance of more than 2,000 miles.

Calculations based upon the assumption that 1 H.P. could be developed for every 100 sq. ft. exposed to solar radiation would lead one to enormous figures if applied to the area above mentioned. For the purpose of example, however, Mr. Ericsson takes a strip of land a single mile in width, along the rainless western coast of America, the southern coast of the Mediterranean, both sides of the alluvial plan of the Nile in Upper Egypt, both sides of the Euphrates and Tigris for a distance of 400 miles above the Persian Gulf, and finally a strip also a mile wide along the rainless portions of the Red Sea above alluded to. The aggregate length of these strips of land, selected on account of their being accessible by water, far exceeds 8,000 miles. The area covered would be about 223,000,000,000 sq. ft., and on the assumption that 100 sq. ft. could produce 1 H.P. during an average of nine hours per day, we are led to the conclusion that by suitable apparatus 22,300,000 engines each of 100 H.P. could be kept working, by utilising only that heat which is now wasted on the assumed small fraction of similar land extending along some of the water fronts of the sunburnt regions of the earth.

These figures are certainly interesting, and it would appear from results of other experimenters that Mr. Ericsson's assumption of 1 H.P. from 100 sq. ft. of receiving area is quite within the bounds of practical possibility. In fact, according to Prof. Thurston, this figure has been confirmed by recent experiments at Pasadena, in California, where it is stated that Ericsson's efficiency has in some cases been attained. The apparatus used in California was a truncated conical mirror, 33 ft. 6 in. in diameter at the top and 15 ft. at the bottom, which concentrates the rays of the sun received upon its 1,788 facets at a focus, where a boiler is placed and steam generated to work a steam engine. The whole mass is moved by clockwork and automatically held with its axis directed towards the sun. The boiler, which is carried on the same frame and moves with the mirror, is 13 ft. 6 in. in length, and contains about 10 cubic ft. of water and 8 cubic ft. of steam space, pressure being maintained at 150 lbs. per sq. in. The apparatus is said to be of 10 H.P., but Prof. Thurston remarks that the reported figures are inconsistent with this rating. It is unfortunate that Prof. Thurston does not quote these figures, which would certainly be of great interest.

It is also unfortunate that most of the areas over which the heat of the sun could be conveniently utilised are entirely devoid of animal or vegetable life, and presumably it would be difficult to establish manufactories or other means of utilising mechanical energy in these regions.

It is not often that nature makes things easy for us. As a rule, the really useful large water-powers are also located in places remote from any form of civilisation, thus severely handicapping the efforts of engineers to utilise the energy of falling water and to turn it to useful account.

There can be no doubt that the exhaustion of our possible fuel supplies is a serious matter, but the old proverb which points out that necessity is the mother of invention will not fail to be equally true when the necessity arises for inventing or discovering some substitute for coal. In fact, the tendency of the last few years goes to show that in the future we may look to our chemists for startling discoveries in fuel for power generation. A great advance, at least

in the economy of fuel consumption, is made by the discovery of Mond gas, and it is more than probable that this discovery will open the way to many similar ones along cognate lines.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Aug. 28th, 1900.		Week ending Aug. 27th, 1901.	
Adelaide	Value £141	Alexandria. Teleg. mat.	Value £75
,, Teleg. wire	700	Amsterdam	80
,, Teleph. mat.	310	Beira. Teleg. mat.	142
Alexandria	189	Calcutta	408
,, Teleg. wire	207	Cape Town	790
Amsterdam	35	Christchurch	12
Bahia	32	Christiania	24
Beira	60	Copenhagen	300
Bombay	208	,, Elec. lighting cable	3,940
Boulogne	24	,, Teleg. wire	19
Buenos Ayres	979	Durban	24
,, Teleg. mat.	740	Fremantle	224
Calcutta	110	Ghent	8
Cape Town	268	Gibraltar	25
Durban	1,920	Hong Kong	10
,, Teleph. mat.	20	Nagasaki. Teleg. cable	5,701
Hamburg. Teleg. mat.	1,230	New York	56
Hobart	53	Perth	476
Hong Kong	349	,, Teleg. cable	5,370
Lisbon. Teleg. apparatus	92	Port Elizabeth	44
Mauritius	74	Rio Janeiro	22
Nagasaki	142	,, Teleg. mat.	166
Ostend	800	Rodriques. Teleg. cable	580,575
Port Elizabeth	148	,, Teleg. mat.	119
Rockhampton	54	Santos	79
Rotterdam. Teleg. wire	115	Singapore	25
Santos	17	,, Teleg. mat.	57
Singapore	160	Stockholm. Teleg. wire	60
Stockholm. Teleg. wire	38	Sydney	480
Sydney	1,641	Tokio	49
Wellington	204	Valparaiso	93
		Wellington	17
Total	£10,651	Total	£599,688

Foreign Goods Transhipped.

Barbadoes. Teleph. apprts.	Value £48	Antwerp. Elec. apparatus	Value £300
Hamburg. Elec. apparatus	30	Baltimore. Elec. machinery	800
Perth. Elec. motor machinery	159	Colombo. Elec. mat.	10
		Hamburg. Elec. goods	170
		Rio Janeiro. Teleg. wire	860
Total	£237	Total	£2,140

Actions.—According to the *Scotsman*, Lord Pearson has disposed of the action brought in the Court of Session by P. R. Jackson & Co., Limited, Salford Rolling Mills, Manchester, against the Glengarnock Iron and Steel Company, Limited, 127, St. Vincent Street, Glasgow, for payment of a sum of £519 10s. 3d. In 1897 the defenders contracted with the pursuers for the supply and erection by the pursuers of an electric pumping plant at the defenders' No. 5 pit, Auchenharvie Colliery, at a price of £2,600. The plant was, the pursuers averred, duly supplied and erected, and some extra work was also executed for which payment was claimed, the sum sued for being the balance of the whole account. The defenders pleaded that their acceptance of the contract expressly stipulated that the whole work should be in accordance w'th their specifications; with the pursuers' estimate of May 28th, 1897; and generally as per tracings submitted by the pursuers; but subject to the defenders' approval of the working plans. Alterations were, the defenders stated, made from time to time by the pursuers on the plant as originally supplied and erected by them with a view of rendering it conform to contract. It was not till February, 1900, that the pursuers succeeded in putting the plant into a condition to perform the work it was guaranteed to do in a satisfactory or efficient manner. During the period from November 1st, 1897, to February 1st, 1900, the defenders were deprived of the use of the pumping plant owing, they said, to the failure of the pursuers to have the same up within the contract time, and to deliver it in an efficient state conform to contract. Lord Pearson has assoilzied the defenders, finding that through the pursuers' undue delay in fulfilling the contract the defenders sustained loss and damage to an amount exceeding the whole claims made by the pursuers. The defenders were allowed expenses.

At Glasgow Sheriff Court, before Sheriff Fyfe, on Tuesday, Mr. Thos. Simpson, coalmaster, Pollokshields, raised an action against the Glasgow Corporation Tramways under the Summary Jurisdiction Act, 1864—1881. The pursuer avers that on 28 separate occasions, between June 3rd and August 20th, the speed of the trams exceeded that allowed by the Board of Trade regulations, viz., eight miles an hour, more particularly on the Pollokshields to Exhibition route; that for each contravention the penalty is £10, and the complainer asked his Lordship to impose a penalty or penalties.

Mr. Campbell, agent for the Corporation, objected that complainant had no title to prosecute without the consent of the Procurator Fiscal. He also pleaded defective specification, in that the complainer did not specify which car or cars exceeded the regulation speed, and in which direction they were travelling.

Mr. Lamond, agent for complainer, pointed out that the Board of Trade regulations were to be read as part of the provisional order for the trams, and that they were framed with the object of securing to the public reasonable protection from accident. The complainer stated that there was considerable risk to himself and family in travelling at such a high speed, on many occasions as high as 22 miles per hour. As to the title of prosecutor to sue, that had already been settled in cases which he cited. These cases, he thought, showed that the objections were like "so many electric sparks emanating from the representative of the Corporation with the object of slipping out of this well founded prosecution by a side wind." (!) As to defective specification, he pointed out that the Corporation had the monopoly of the tramway system, and that it was merely necessary to say certain days.

After further discussion, the Sheriff intimated that he would give judgment on the relevancy on September 3rd.

Auction Sale.—An electrical engineer's machinery and stock-in-trade are to be sold by auction at Halifax on September 6th. See "Official Notices" to-day.

Books Received.—"Journal of the Institution of Electrical Engineers," No. 152, Vol. xxx., August, 1901; "Index to the Journal," Vol. xxx.; also index to Vols. xxi. to xxx., 1892—1901; "List of Officers and Members of Institution of Electrical Engineers." London: E. & F. N. Spon, 4s. and 2s. 6d. respectively.

"Transactions of the North-East Coast Institution of Engineers and Shipbuilders," Parts 5, 6, 7 and 8, May and July. London and Newcastle-on-Tyne: Andrew Reid & Co., Limited, 1901.

"Trade Marks," by Ernest Salaman. The Mercantile Publishing Syndicate, Limited. 1s.

British Artisans on Tour in America.—Messrs. W. and D. C. Thomson, proprietors of the *Red Letter*, have just sent to America in connection with that paper an expedition of 12 representative working men to investigate and report upon labour conditions. The delegates, who were elected by popular vote, represent such industries as mining, electrical and mechanical engineering, the pottery trade, railway work, coachbuilding, metallurgy, cabinet-making and upholstering, textile manufactures, &c. The entire expenses of the expedition are being paid by Messrs. Thomson.

Catalogues and Lists.—The Lancashire Dynamo and Motor Company send us a catalogue and price list of their dynamos and motors, which vies with the latter in excellence of finish; the illustrations are capital, not only as artistic productions, but also on account of their intrinsic interest and novelty. The company's standard machines are built to stock in sets of 50, from 1 kw. to 16 kw., and the larger sizes in smaller quantities, enabling prompt delivery to be effected. A list of 90 customers, with their orders amounting to 370 machines, shows how rapidly the firm has built up a sound connection since it started in June last year.

Messrs. R. W. Blackwell & Co. send us a price list of their "Column" type indicating and recording volt and amperemeters, of which we gave a description in our issue of August 16th.

Messrs. S. N. Wolff & Co., of Wevelinghofen, forward lists of their electrical goods, comprising lamp shades, globes, battery jars, vacuum tubes, glow lamps, various porcelain and small metal articles, bells and their accessories, dry batteries, switches, lamp-holders, &c. Desk fans, and an interesting novelty called the "Zwerg-Telephon," are also listed.

The Electrische Bogenlampen-und Armaturen-Fabrik send us a catalogue of their arc lamps for direct and alternating currents, open and enclosed. The former burn three in series on 110 volts D.C. Arc lamp resistances, transformers, cut-outs, &c., are also listed.

China.—H.M. Consul-General at Canton, in a recent report, states that there is a considerable and probably increasing demand for all kinds of electrical apparatus in the shape of phonographs, telephones, Röntgen rays apparatus, gramophones, and cinematographs. Why phonographs, gramophones, &c., should be classed as electrical apparatus is past understanding; but the importance of the actual and possible trade with China in small electrical wares ought not to be overlooked by our manufacturers.

Woking.—The Automotor Industries, Limited, have established works at Woking for the manufacture of batteries similar to those being used on the "Powerful," an electrically propelled motor carriage now making a tour of the United Kingdom. The "Powerful" proceeded from London to Sheffield in two days, a distance of 157 miles, and was recharged at the Sheffield Corporation works. The average cost for energy per mile works out at 1½d., a total mileage of 1,837 miles having been negotiated with about 950 units of electricity. Mr. H. Leitner, who is organising the tour, is manager of the works at Woking.

Wolverhampton.—The International Exhibition to be held in Wolverhampton next year has every prospect of success; the guarantee fund already amounts to over £30,000. The Earl of Dartmouth (the Lord-Lieutenant of the county of Stafford) is President, and is supported by an influential committee. Lord Barnard has granted part of the site, and an area of over 30 acres is made up of a portion of the beautiful Park, including a lake, belonging to the town. Mr. H. A. Hedley, the general manager of the phenomenally successful Glasgow Exhibition, and Messrs. Walker and Ramsey, the architects of part of the buildings of that undertaking, are now engaged in maturing the plans of the buildings, in which provision is made for the display of machinery, assurances of exhibits from many leading engineering firms having already been obtained. Intending exhibitors are reminded that applications must be received not later than October 1st next, at Gresham Chambers, Wolverhampton.

(Continued on page 357.)

GLASGOW ELECTRIC TRAMWAYS.

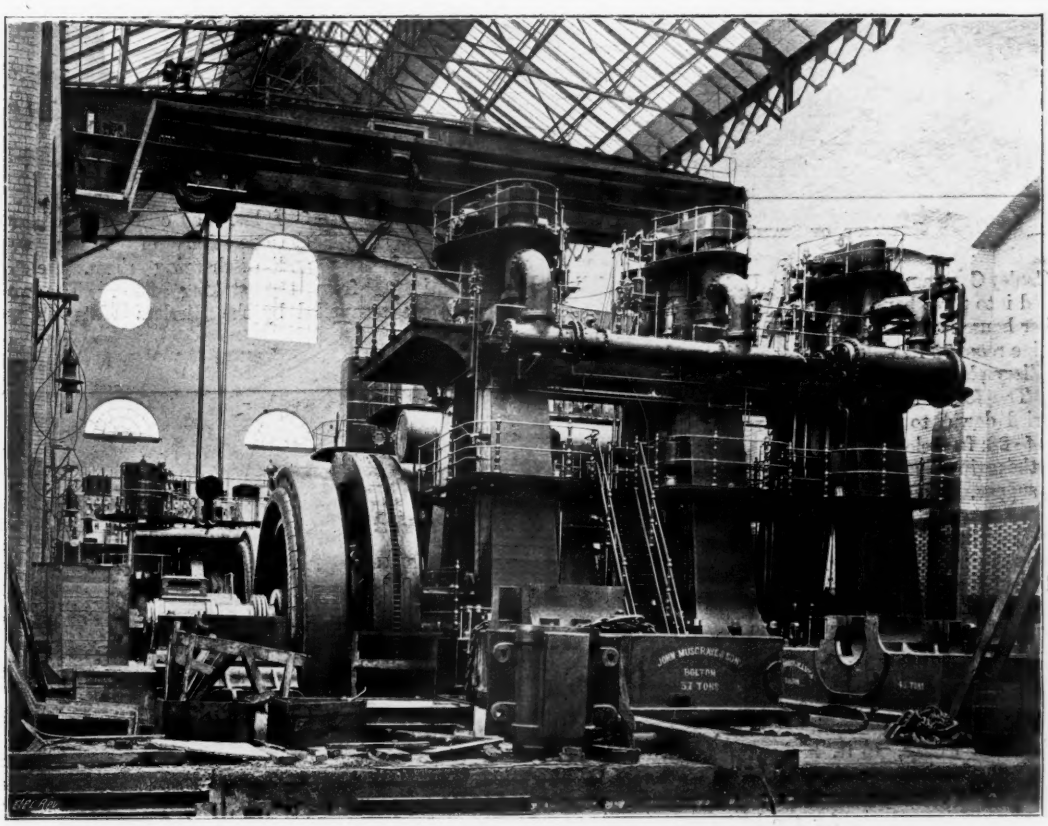
From their very beginning, the tramways of Glasgow have been under the control of the Corporation; as far back as 1870, when proposals were brought forward for constructing tramways in the city, to be worked by animal haulage, the Corporation took matters into its own hands and carried out the work. The tramways were leased to a company until 1894; on the expiry of the lease the Corporation decided to work the tramways in future on its own account. At the same time the question of adopting some form of mechanical traction was considered, but for the time being the tramways continued to be worked by horses. When the system was taken over, it comprised about 31 miles of double track. Halfpenny fares were instituted by the Council, and the undertaking, under the able management of Mr. John Young, has been highly successful and financially profitable.

In 1896 Mr. Young and Councillor Crawford visited various Continental cities to inquire into the systems of mechanical traction in actual use, and on their return issued an exhaustive report, which strongly favoured the overhead trolley system of electric traction. The conclusions of the report were confirmed by a sub-committee, which visited a number of the most important Continental systems in the same year; Mr. Young and Mr. W. Clark, the city tramways engineer, also went to America to make further investigations, with the same result.

In consequence of these inquiries, the Corporation proceeded to equip the Springburn section of the tramways on the overhead system as an experiment; this installation, which comprised 4¼ miles of double track, was described in our issues of October 21st and 28th, 1898. The results obtained proved highly satisfactory, and in the following year the Corporation decided to convert the whole of the tramway system to electrical working. For this purpose Mr. H. F. Parshall was retained to report on the whole subject, and to draw up a scheme for carrying out the work. Mr. Parshall estimated that the generating plant should have a capacity of 17,000 H.P., to provide power for a total of 600 cars.

As the wide extent of the existing and proposed tramway routes altogether precluded the possibility of supplying the necessary power from a single generating station at low pressure, the question whether a single high pressure generating station, with converting sub-stations, or a number of separate low pressure generating stations, should be employed, at once arose; in his report Mr. Parshall fully discussed these alternatives, and decided in favour of the single high pressure station, with five distributing sub-stations. It was recommended that there should be four main generating sets, of which one should be held in reserve; the generating pressure was fixed at 6,500 volts, and the three-phase system was chosen.

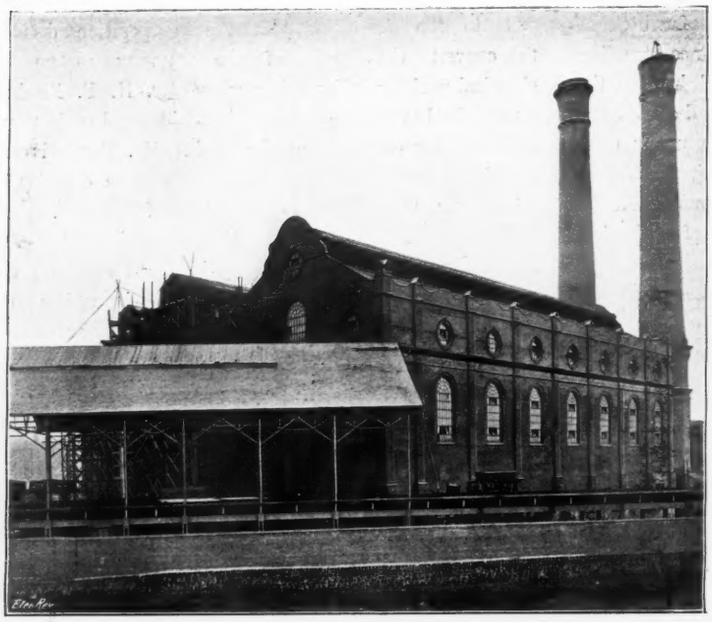
Mr. Parshall's scheme was adopted by the Corporation, and the work was put in hand at once. The site selected for the power station was at Pinkston, near Port Dundas, on the Forth and Clyde Canal. The Caledonian and North British Railways bound two sides of the site, and the canal a third, so that the site is especially favourable for the economical supply of both water and coal.



Musgrave 500,0-h.p. Engine and British Thomson-Houston Alternator.

F

The framework of the building is of steel, filled in with brick; the whole of the steel work was carried out by the Riter Conley Company, of Pittsburg, U.S.A. The building is divided into three bays, each of which is 244 ft. in length; the boiler house is 84 ft. wide and 70 ft. high to the eaves, the engine room 75 ft. wide × 64 ft. high, and the auxiliary plant room 40 ft. wide × 52 ft. high. The foundations are of concrete, and are carried down to the sandstone, reaching a depth of 28 ft. below ground level in some cases; the main columns are carried by granite blocks supported on the concrete. Riveted lattice trusses are used in the roof construction, and are interbraced, so as to rigidly brace the three bays of the roof together.



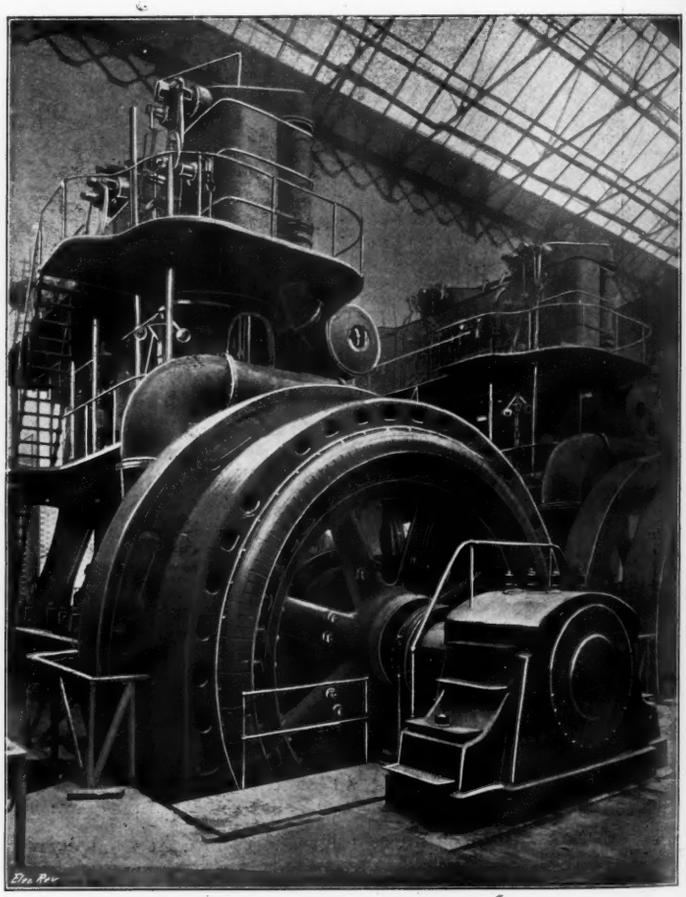
Exterior of Station, showing Coal Sidings.

Coal is brought to the station by both the Caledonian and the North British Railways, from which sidings have been laid to the boiler house. These sidings are on two different levels, the North British siding, with one track, being on the same level as the ground floor of the generating station, and the Caledonian siding, 15 ft. higher, with six tracks. Beneath these there is a range of coal bunkers, with eight receiving hoppers for the high level sidings, and one for the low level. The bunkers have a total capacity of 4,000 tons; they are built of steel plate, and are supported on columns. They are provided with hoppers, from which the coal is fed into the coal conveyors. The coal bunkers, and all other steel work outside the main buildings, were constructed by Sir W. Arrol & Co.

There are two coal conveyors, of the gravity bucket type, each having 365 buckets, and extending to a total length of 860 ft., of which 107 ft. at each end of the boiler house is vertical. Each bucket is capable of holding about 1 cwt. of coal; the conveyors move at the rate of 45 ft. per minute, and are each capable of handling 50 tons of coal per hour. They are driven by enclosed motors, fixed at the top of the boiler house; these were supplied by Messrs. J. P. Hall & Co., of Oldham, and are shunt wound for 500 volts, 200 revolutions per minute. A revolving automatic filler of novel design is provided for each conveyor, which can be moved on rails under the bunkers to any desired position. For emptying the buckets into the bunkers at the top of the boiler house special tilting devices are employed, which can be moved to any point where the coal is to be tipped; these consist of levers which engage with the buckets as they pass by, and gradually turn them over. The whole of the conveyor plant was supplied by the Mirrlees Watson Company, Limited, of Glasgow.

The conveyors discharge into bunkers situated at the top of the boiler house; these are also of steel, forming part of the Riter Conley Company's contract, and extend the whole length of the boiler house. At one end of the latter separate ash bunkers are provided; the conveyors, passing through the tunnel beneath the stoking floor, collect the ashes from shoots through four movable ash fillers, and carry them up to these bunkers, from which they are transferred by means of shoots to railway trucks.

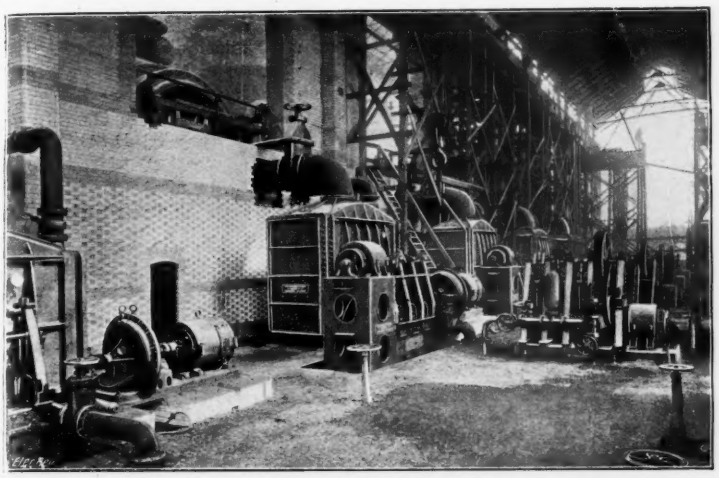
Above each boiler furnace the overhead bunker is provided with a spout, controlled by a valve; just beneath this is a railway, along which run hopper weighing machines, one to each boiler. The hopper and shoot have a capacity of about 500 lbs. of coal per charge, and the operations of filling, weighing and discharging them, are carried out entirely from the stoking floor. The weighing hoppers were supplied by the Mirrlees Watson Company, Limited.



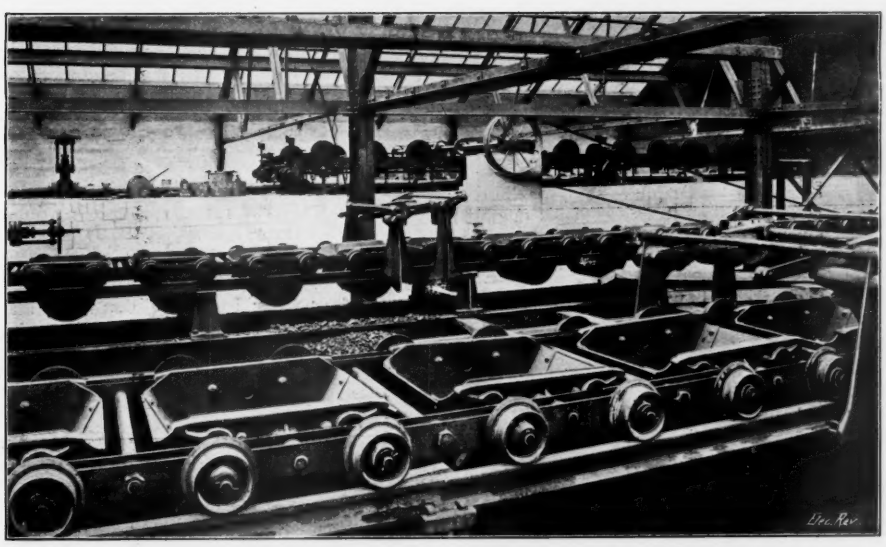
Allis 5,000-h.p. Engines and B.T.H. Alternators.

The steam raising plant consists of 16 pairs of Babcock

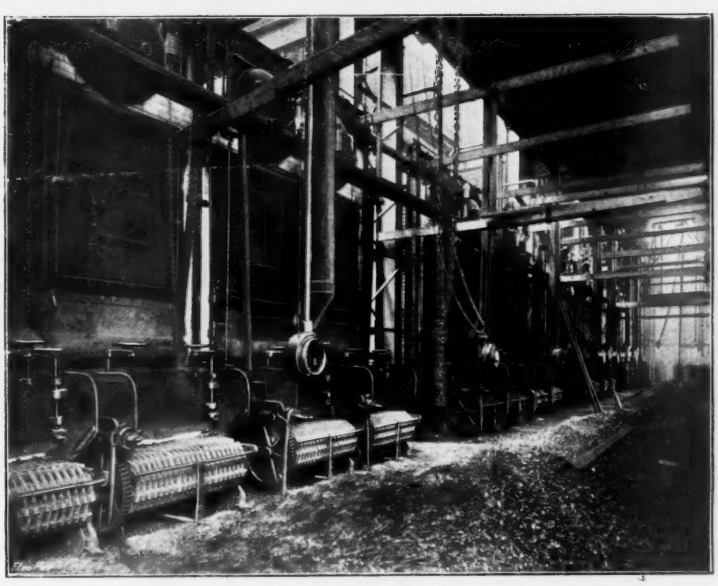
and Wilcox boilers, arranged in eight batteries, four on either side of the boiler house. These are of Messrs. Babcock & Wilcox's standard type, each having a heating surface of 5,173 sq. ft., and being capable of evaporating 25,000 lbs. of water per hour at a pressure of 160 lbs. per sq. in. The boilers are fitted with the makers' "Scotch" furnace, and with their superheaters and chain grate stokers. The latter are driven by two lines of shafting beneath the floor, each of which is coupled to a 12-H.P. Westinghouse motor; both lines can be driven by either motor if necessary. A separate steel flue is provided for each row of boilers, supported on girders above the boilers; the flue is 16 ft. 9 in. high at the chimney, and tapers to 10 ft. 3 in. at the smaller end, the breadth being 8 ft. throughout. Each of the flues is 176 ft. long, and weighs about 100 tons; they were supplied by Messrs. Mechan & Sons, of Glasgow. Two economisers, each capable of heating 12,000 gallons of water per hour from 90° to 160° F., are provided, being connected with the respective main flues, and furnished with dampers and by-passes. These were the work of the Clay Cross Company.



Condenser and Pump Room.



Conveyor and Economiser.



Water-tube Boilers.

The two chimneys are built of brick, and are octagonal up to a height of 103 ft., after which they are circular in section; their proportions are unusually pleasing, and it is difficult to realise that they are 250 ft. in height from the floor level of the boiler room. The total height from the top of the foundations is 277 ft. 6 in., and the inside diameter at the top is 16 ft. 9 in. The chimneys are lined with fire brick, and are surmounted by heavy cast-iron copings.

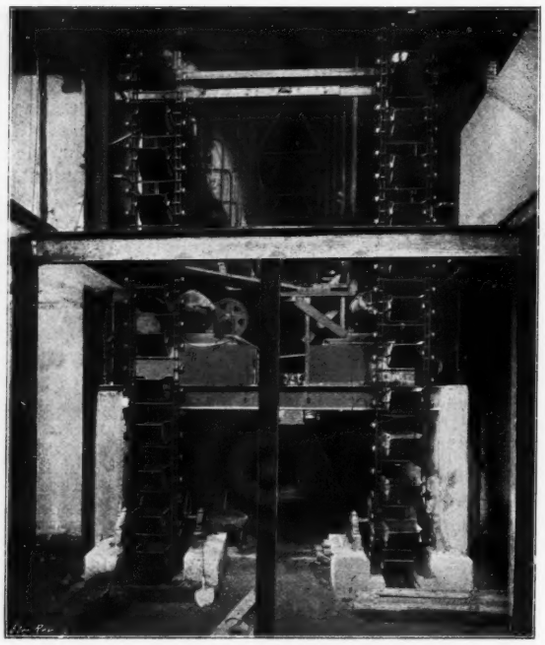
A noteworthy feature of this power station is the fact that the steam-raising plant is divided into two sections, which are absolutely independent and self-contained in every particular, thus providing a very high degree of security against a breakdown.

All the boilers feed into a main header in the boiler room, 16 in. in diameter; the two boilers forming each battery are coupled together by a 7-in. pipe, from which a 9-in. pipe is teed to join the main pipe. The latter is made in two sections, joined at the middle by steel expansion bends. The steam pipes to the main engines are taken overhead through the boiler-house wall, and are 14 in. in diameter in the case of the Allis engines, 15 in. for the Musgrave engines. All the steam, exhaust and feed piping was carried out by Messrs. Babcock & Wilcox.

In the engine room there are four main generating sets, two auxiliary sets, and six exciter sets.

All the main engines are of the three-cylinder three-crank vertical compound condensing type, with Corliss valve gear, having a normal capacity of 4,000 I.H.P. at 150 lbs. per sq. in., and a continuous maximum output of 5,000 I.H.P.; they

run at 75 revolutions per minute, with a maximum variation of 1½ per cent. between no load and maximum load, and an angular variation not exceeding ⅛ of 1 per cent. in 1 revolution. Two of the engines were supplied by the E. P. Allis Company, of Milwaukee, and two by Messrs. Musgrave and Sons, of Bolton.



End of Conveyor Tunnel.

The Allis engines have cylinders 42, 62, and 62 in. in diameter, with a stroke of 60 in. The valve gear is of the Reynolds-Corliss type, with double-ported valves in the cylinder heads. The speed is controlled by a governor which acts on both high and low pressure gears. The piston rods are 8 in. in diameter, and the crank pins 12, 16 and 20 in. diameter × 12 in. long. The two low pressure crank-pins are rigidly fixed into the webs of one side only—that next the alternator—the other ends being given a slight play, so as to allow for slight inaccuracies of alignment due to settlement, and to facilitate erection. The first and second bearings of the crankshaft are 22 in. diameter × 36 in. long; the third and fourth 24 × 36; the fifth 32 × 64, and the outer bearing 30 × 48 in. The diameter of the shaft in the hubs of the fly-wheel and magnet wheel is 36 in. The fly-wheel is 24 ft. 4 in. in diameter, made in 10 parts, and weighs 105 tons; the whole engine weighs 650 tons, and, with the generator, occupies a floor space of 52 × 24 ft.

The high pressure cylinder alone is jacketted, and the receiver is provided with a reheater coil fed with live steam.

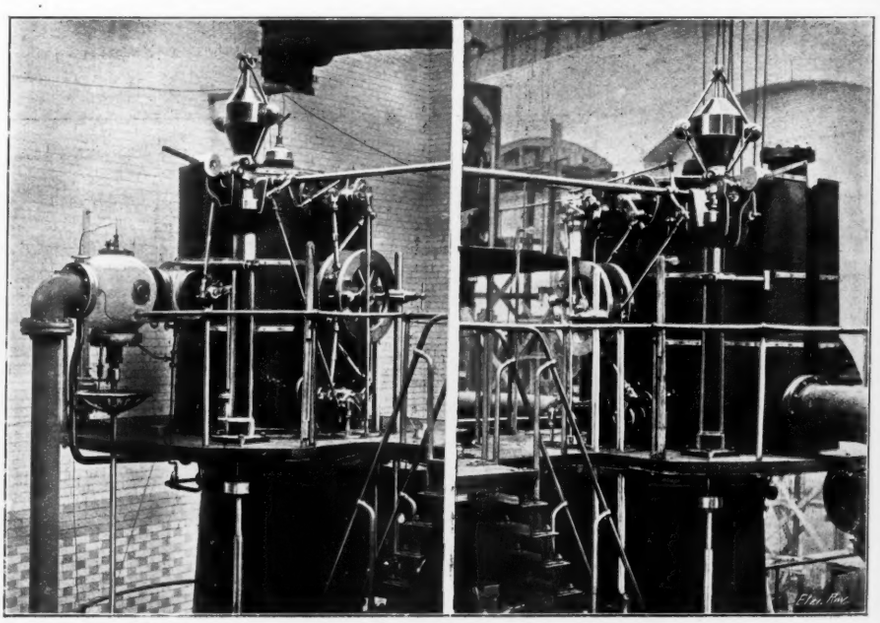
The Musgrave engines have cylinders 42, 60 and 60 in. in diameter, with 60 in. stroke; the valve gear is of the Musgrave trip Corliss type. The piston rods are 9 in. in diameter, and the crank pins 14, 18 and 22 in. diameter × 14 in. long. The crankshaft is in two pieces, weighing respectively 52 and 30 tons; the bearings are of the same dimensions as those of the Allis engines. The fly-wheel weighs 145 tons, of which 90 tons are in the rim, and the whole engine weighs 750 tons. The high pressure cylinder is jacketed with live steam, and the receiver is built like a surface condenser, steam at boiler pressure being passed through the tubes, which are surrounded by the exhaust steam from the high pressure cylinder. A 5-in. pipe passes through the centre of the receiver, by means of which steam can be taken from the boilers through a reducing valve to the low pressure cylinders for starting up.

All the main engines are provided with emergency governors, which cut off the steam if the speed rises 5 per cent. above normal.

The two auxiliary engines were made by Messrs. D. Stewart & Co., Limited, of Glasgow, and are designed to give a normal output of 800 I.H.P., a continuous maximum of 1,000 I.H.P., and for a short period 1,200 I.H.P.; they are of the two-cylinder vertical cross-compound type, condensing, with the generators between the high and low-pressure cranks. The cylinders are 22 and 44 in. diameter × 42 in. stroke, with valve gear of the Reynolds-Corliss type; the piston rods are 5½ in. in diameter, and the crank pins 6½ in. × 7 in long. The main bearings are 18 in. in diameter × 36 in long, and the shaft is 20 in. diameter in the fly-wheel. The latter is 19 ft. in diameter, and weighs 34 tons, of which 23 tons are in the rim.

The normal speed is 90 revolutions per minute, and there are two governors, one of which is for emergency.

The six exciter engines are of the high-speed vertical compound enclosed type, and were supplied by Messrs. W. H. Allen, Son & Co., of Bedford. Each engine is rated at 100 I.H.P., at 300 revolutions per minute; the cylinders are 11 and 19 in. diameter × 8 in. stroke, and each is fitted with one piston valve. Forced lubrication is provided for all working parts. Special provision is made for preventing water from the piston rod stuffing box from finding its way into the trunk, and the latter is provided with hinged doors so as to give ready access to the crank chamber. All the bearing surfaces are large, and an additional large bearing is provided at the generator end of the shaft to carry the weight of the armature. The mechanical efficiency of these engines is stated to be 92 per cent. at full load.



Valve Gear of Stewart 1,000-H.P. Engine.

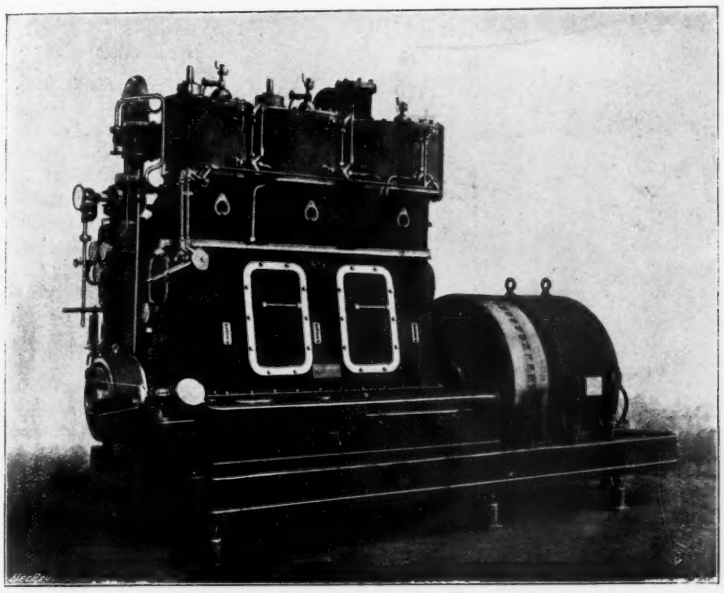
All the electrical generators coupled to the main, auxiliary and exciter engines were supplied by the British Thomson-Houston Company, and will be described later.

(*To be continued.*)

GLASGOW INTERNATIONAL EXHIBITION, 1901.

VII.

Messrs. D. Bruce Peebles & Co. have supplied to the power department a dynamo, driven by one of Messrs.



Belliss and Morcom Engine and Bruce Peebles Dynamo.

Belliss & Morcom's engines, in addition to the balancer described in our last article.

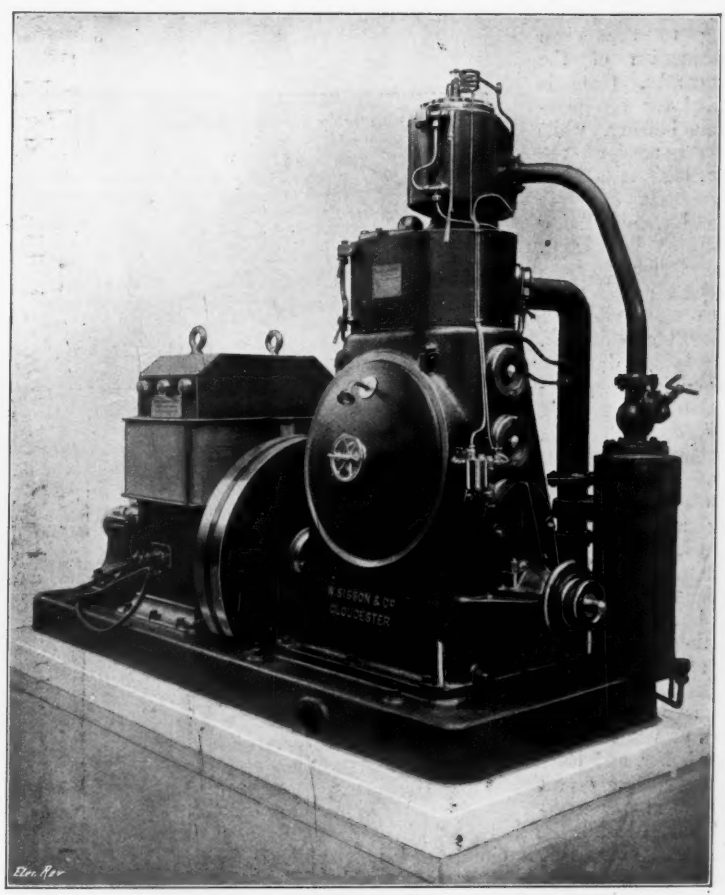
The dynamo is of the four-pole shunt-wound type, giving 380 amperes at 460—530 volts, 400 revolutions per minute. The yoke ring is circular, and presents a very neat appearance; inside the poles a steel cylinder is fitted, cut away between the poles.

The armature is of the drum type, with slotted core; it is well ventilated, and runs sparklessly, without shifting the brushes, from zero load to 25 per cent. overload. The carbon brushes are in four sets of five, and are shifted by means of a simple screw and nut adjusting gear.

The Belliss engine is of the three-crank triple-expansion double-acting type, having cylinders 12 in., 17 in., and 24 in. in diameter, with a stroke of 10 in., designed to give 350 B.H.P. The valves are of the piston type. The steam passages between the several cylinders are so arranged as to, as far as possible, separate the water of condensation from the live steam, by slanting upwards from the higher pressure to the lower. The steam separator itself is specially modified to allow of the steam pipe being connected with it from below. The speed is controlled by a centrifugal governor on the shaft, acting on a double-beat throttle valve. The system of forced lubrication, which was originated by Messrs. Belliss in 1890, and has since been progressively improved by them, is employed, a pump without valves or packing being used to force oil to all the working parts except the cylinders. The engine runs extremely quietly and well, and is very highly finished; the Russian iron covering of the steam pipes, by Messrs. Jones & Horsfield, gives a very handsome appearance to these parts. A fly-wheel of about 4 tons weight is fixed between the crank-shaft and the armature. The engine bed is mounted on the top of a large bed-plate, which also carries the dynamo.

An extra long distance piece is provided between the cylinder and the crank chamber, so that the active part of the piston rod does not enter the latter; this prevents the introduction of oil into the cylinder upon the rod. The oil and water are drained to a pocket, and the oil only is returned to the crank chamber.

There is a bye-pass for warming the cylinders before starting, and, thanks to the separator action of the receiver pipes mentioned above, it is possible to throw full load on the engine almost at once. The only oil cup used is on the governor sleeve, which, as well as the rod, is of aluminium. Metallic (Newcastle) packing is used on all the rods except the governor spindle, which is not packed at all; yet there is no leakage while running. The water which drips from it at the start goes into the hollow governor rod, and is led away from the lower end of it. The I.P. and L.P. cylinders are drained into the exhaust pipe, while a separate drain pipe is provided for the H.P. cylinder. Small doors are provided for the indicator gear, and each of the main doors of the crank chamber carries a smaller door, which facilitates inspection without usually requiring the whole door to be opened. Pressure gauges are provided for all three cylinders.

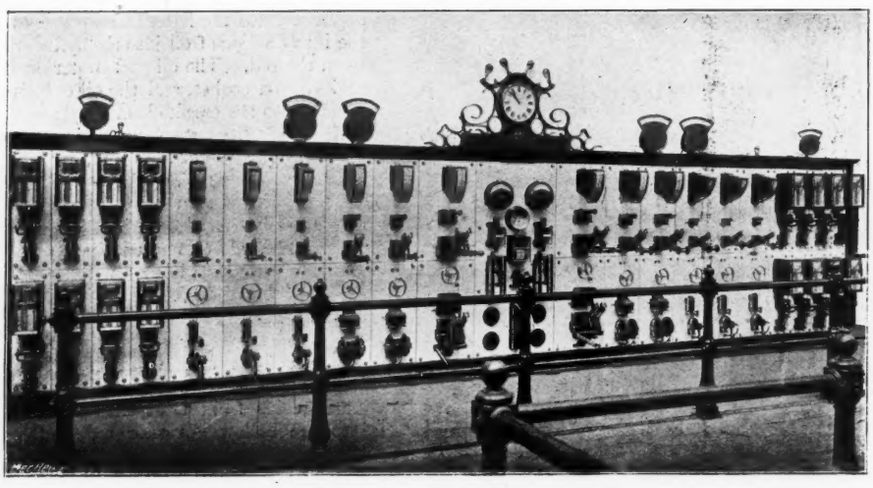


Sisson Engine and Clarke-Chapman Dynamo.

Messrs. Belliss, we understand, have no fewer than 17 similar triple-expansion engines in hand, of 1,200 B.H.P. each, and one set of 2,200 B.H.P.; two of their 1,500-I.H.P. engines are installed in the Port Dundas Electricity Works, Glasgow.

Messrs. W. Sisson & Co. exhibit in the Power Department a double-acting compound engine of a very interesting type, the high-pressure cylinder being raised and overlapping the low-pressure cylinder; the cranks are opposite, and both valves are on one rod, which is controlled by a shaft governor, giving automatic variable expansion. The extra length of the high-pressure piston rod is made use of for the purpose of balancing the moving parts, which is very carefully done. Owing to the close approximation of the two cranks, there is no need for an intermediate bearing, while the pressures of the connecting rods are practically mutually balanced, thus relieving the main bearings. Obviously, for the same reason, the couple tending to set up vibration is greatly reduced. There is no difficulty in examining or removing the low-pressure piston, as clearance is left above the cylinder cover. The cylinders are 9 and 15 in. diameter × 8 in. stroke, and the engine gives 125 B.H.P. at 400 revolutions per minute. The brasses are self-adjusting, and a novel device for attaching the crosshead to the piston rod is used. The valve rod is provided with a spring buffer, and there is an exceedingly neat arrangement for varying the speed while the engine is running. Water circulation is provided for cooling the crank chamber; splash lubrication is used. Sectional views of a similar engine were given in our issue of May 24th last.

The engine is direct-coupled to a dynamo built by Messrs. Clarke, Chapman & Co., giving 400 amperes at 220—250 volts. This machine is of the two-pole undertype, shunt wound; the armature is of the drum type, with evolute end connections. The brushes are of copper gauze, and the bearings are provided with the usual ring lubrication.



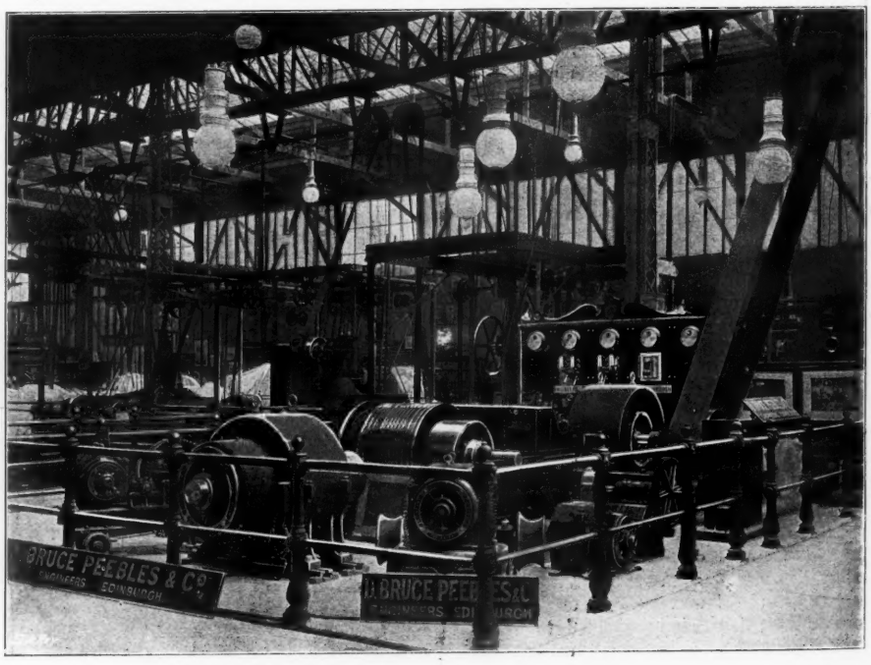
Kelvin & James White Switchboard.

Messrs. Kelvin & James White, Limited, have a very handsome exhibit, consisting of a switchboard controlling the distribution of lighting and power to the whole of the Exhibition. The board is arranged for the three-wire system, having 500 volts across the outers, and panels are provided for 12 generators and eight feeders, dealing in all with 3,000 KW.

The middle panel is fitted with Kelvin S.R. pattern bar and dynamo voltmeters, standard multicellular electrostatic voltmeters, recording voltmeters, earth current recorder, middle wire and earth ampere gauges, automatic short-circuiting switch for earth current recorder, and voltmeter switches. The balancing and pilot voltmeters are of the Thistle illuminated dial type, and are mounted on swivel brackets on the top of the switchboard frame.

Each dynamo has a positive and negative panel, one mounted directly above the other. The positive panels of the six largest generator sets are fitted with S.R. (moving coil) pattern ampere gauges, having shunts at the back of the board; the six smaller sets have plunger type edgewise ampere gauges.

Each positive panel is also fitted with a main switch of the edgewise type, fitted with carbon breaks. Each negative panel is fitted with a Ferguson and White's patent automatic maximum and return current cut-out, with blow-out screens, the dynamo field regulator hand wheel, and a pair of sockets for a Kelvin portable paralleling voltmeter. Five of the largest dynamos generate at 500 volts, and seven of the smaller ones at 250 volts, three being connected on the

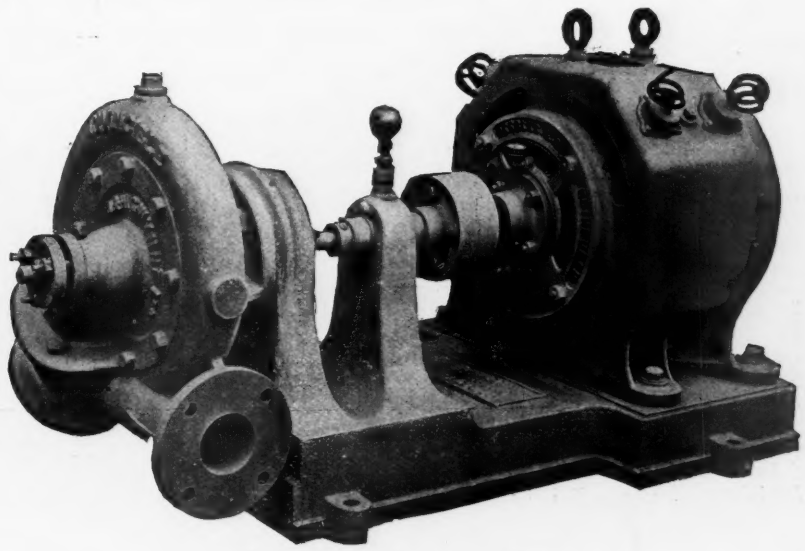


Messrs. D. Bruce Peebles & Co.'s Stand.

positive side and four on the negative side. At the left-hand end of the switchboard are fixed eight positive feeder panels, and at the right-hand end are the corresponding eight negative panels. Each panel is fitted with an edge-wise switch for 750 amperes and a Kelvin feeder log. This instrument indicates and records the current flowing in the feeder, as well as the voltage at the feeding point.

The whole of the panels are of polished white marble, carried on a steel framework; a polished teakwood moulding is fitted round the top and sides. The whole is surmounted by an ornamental iron scroll, in which is fitted an electric synchronised clock controlled by a regulator in the exhibit of Messrs. Kelvin and James White, Limited, in the Grand Avenue. This regulator also controls the clocks in the recording drums of the feeder logs. The entire switchboard, with its equipment of instruments, switches, &c., is of Messrs. Kelvin & James White's own manufacture.

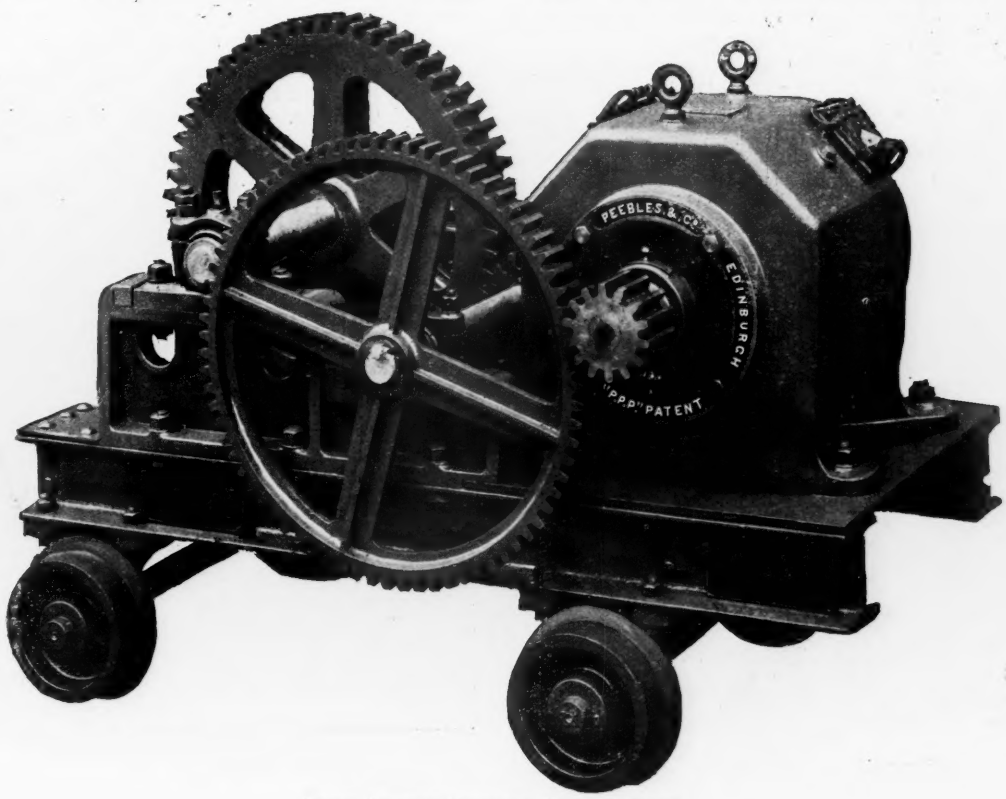
The general scheme for the supply of power and light to the Exhibition is carried out on the three-wire system, with 500 volts between the outers, thus securing uniformity with the Corporation supply to the city. The total capacity of the generating plant is 3,000 KW., but the maximum summer load was 600 KW., in addition to 600 KW. supplied from the Corporation mains. There are six feeders running from the switchboard to the Industrial Hall, the Grand Avenue, and the top end of the Machinery Hall, to supply all parts of the main buildings; there are also two power rings in the Machinery Hall for the supply of motors at 500 volts. All the feeders are of triple-concentric cable, 0·25, 0·15, 0·25 sq. in., paper insulated and lead-covered, of the B.I.W. Company's manufacture. The power rings are of 0·5 sq. in. cross-section. The Corporation supplies coal, water, oil and waste, and other stores for the power department, and charges exhibitors 2d. per unit for motive power; for lighting the charge is 30s. per 16-C.P. lamp, inclusive of wiring, or, alternatively, 15s. for the wiring, and 2d. per unit for the energy consumed.



Bruce Peebles Centrifugal Pump.

There is a distribution board, in charge of an attendant, at each of the three feeding points, communicating by telephone with the main switchboard. The blowing of a fuse on these secondary boards is no uncommon occurrence.

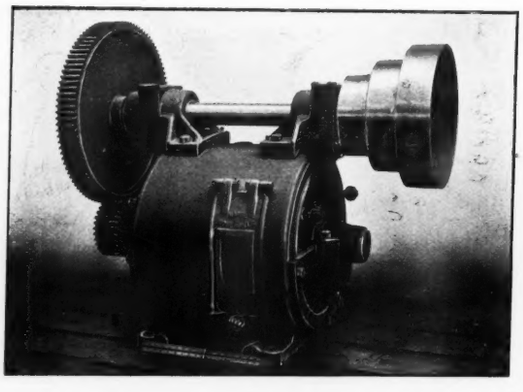
There is a change-over switch to the city mains on each distribution board. At night time one of the feeders is thus connected with the city mains and paralleled with the generating plant at the main switchboard, after which the Exhibition plant is shut down, and the city mains, through the said feeder, supply the main board, and through it the distribution boards, during the night.



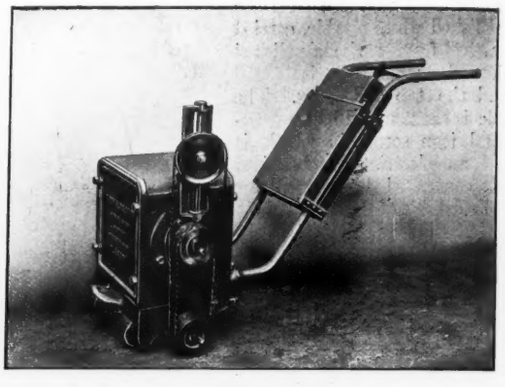
Bruce Peebles Portable Hauling Plant.

Pilot circuits are kept alive throughout the buildings at night.

All the arc lamps for general lighting are of the "Brochipel" type, run 10 in series; the Jackson-Mensing lamps at Messrs. Bruce Peebles & Co.'s stand are on a private circuit. All the outdoor lamps are wired with aluminium wire, supplied by the British Aluminium Company. Our thanks are due to Mr. Ward, mains superintendent to the Corporation, who organised and superintended the installation, and to the various exhibitors for the foregoing particulars.



Mavor & Coulson Geared Motor.



Mavor & Coulson Deck Planer.

Messrs. D. Bruce Peebles & Co.

Besides their dynamo and balancer in the Power Department, Messrs. Bruce Peebles devote a 150 B.H.P. four-pole motor to driving the main shafting in the Machinery Hall at their stand. This is one of their standard P.P.P. machines, No. 16, running at 400 revolutions per minute. The frame and poles are of cast-steel, the frame being divided on the horizontal diameter. Inside the pole-ring is a steel cylinder, cut away and bevelled between the poles. The field coils are wound pyramidally, for shunt excitation. The armature is barrel wound. The brush regulating gear is very well designed, but the brushes need no shifting, running absolutely without sparking at all loads. The armature core is well ventilated both axially and radially, and the winding is extremely neat. The commutator is also well made. The machine is built on a heavy cast-iron bed, and presents a very handsome appearance; indeed, it is difficult to describe it without appearing to overrate its qualities.

Traction Generator Armature.—This large armature, intended for driving a paper mill, and rated at 264 KW., is shown without its field magnets. There is no coupling on the shaft, the armature spider being provided with a flange for bolting direct to the fly-wheel of a Willans engine. The construction of the armature is simil to that of the large motor, and leaves no opening for criticism. The commutator is especially massive; it is put together under hydraulic pressure, and so designed that the bars cannot be forced in by a blow.

Enclosed four-pole Mining Motor.—The shell of this motor consists of two castings, with end plates carrying the bearings, and is gas and water tight. The motor is of 40 B.H.P. and drives by belt. The design is such as to withstand the most severe treatment, and to work under the worst conditions of damp and dirt.

Electrical Capstan.—A capstan for ship work, driven by a four-pole 10-H.P. motor, on a single base, forms another exhibit. The motor is semi-enclosed, with frame in one piece, and runs at 700 revolutions per minute; double worm and wheel gearing running in oil is used to drive the capstan, with a speed ratio of 20 : 1.

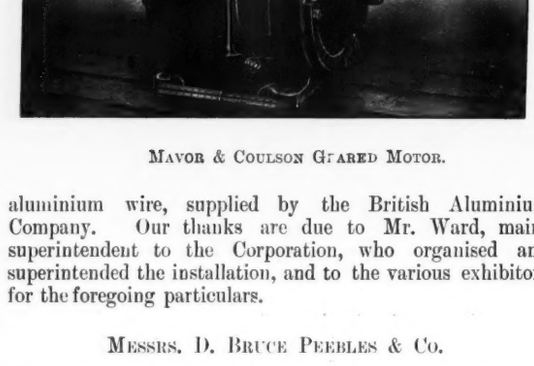
Similar machines are standardised from 5 to 50 H.P.; the efficiency overall is over 70 per cent., which compares favourably with that of a steam capstan, taking at least 100 lbs. of steam per B.H.P.-hour.

Centrifugal Pump.—This is driven by a semi-enclosed motor of 5 B.H.P., running at 1,400 revolutions per minute.

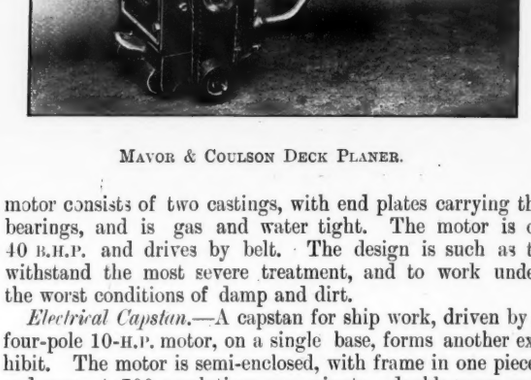
Geared Motor.—A standard P.P.P 5 H.P. motor, provided with self-contained spur gear, reducing the speed from 100 to 40 revolutions per minute, is shown.

Haulage Plant.—This is mounted on a wheeled truck; a double-reduction spur gear is used, the pinion being of raw hide. The motor is semi-enclosed, of 6 B.H.P., running at 800 revolutions per minute; larger sizes are made up to 100 B.H.P.

Semi-enclosed motors for direct coupling and belt drive respectively, are also shown. Over a thousand of these, we understand, are annually supplied for general power work.



Mavor & Coulson Mining Pump.



Mavor & Coulson Portable Drill.

Messrs. Mavor and Coulson.

As befits their position as the pioneers of public electricity

supply in Glasgow, Messrs. Mavor & Coulson have a large and varied exhibit at their stand, as well as the 385-KW. and 180-KW. generators already described in connection with the power department.

Geared Mining Pump. — On their stand Messrs. Mavor & Coulson show one of their enclosed motors coupled to a triplex ram pump, made by Messrs. J. H. Carruthers and Co., of Glasgow. The rams are 3½ in. diameter × 6 in. stroke, and are arranged to run at 30 revolutions per minute, delivering 1,000 gallons per hour against a head of 1,000 ft. The shaft and connecting rods are of forged steel; the gear wheels all have machine-cut teeth, and the soleplate of the pump is extended to receive the electric motor. The latter is of the enclosed four-pole type, adapted for a working pressure of 500 volts, and the combination is specially designed for mining work.

Deck Planing Machine.—This is a portable wood planing machine provided with 3-H.P. motor, running at a speed of about 3,000 revolutions per minute and driving by band the cutting knives at a similar speed. The machine in general appearance is similar to a lawn mower. This machine is found by shipbuilders to be of great advantage in the planing of ships' decks, which when carried out by hand is a very slow and tedious process. The machine performs its work quickly and well, and effects a large saving in cost. During recent years a number of these machines have been supplied to shipbuilders in Germany and in America, and repeat orders are evidence of the satisfactory work performed.

Portable Electric Drill. — This machine is intended primarily for the use of shipbuilders and engineers, and its substantial design adapts it for withstanding hard work and rough usage. The motor is of the two-pole enclosed type, with cast-steel shell, and is mounted upon wheels. Speed-reducing gear is provided, which drives the drill through a telescopic shaft and Hooke's joint. For small holes, or for driving an emery wheel or lighter work, a flexible shaft is used, coupled direct to the motor shaft, instead of the telescopic shaft. The machine exhibited is one of the medium size, but the same type is made in a larger size and smaller sizes, covering a range of holes from ½ in. up to 2 in. diameter.

Motor with Geared Countershaft.—A small two-pole enclosed motor of 1 H.P., with cast-steel shell, carries in two bearings a short countershaft, which is driven through raw hide and cut spur wheels from the motor spindle, effecting a reduction from about 1,000 revolutions to 200 revolutions per minute. The power may be taken from the low speed shaft by means of gear, chain or belt. These are made up to 3 H.P.

25-B.H.P. Ship-lighting Set.—This set consists of an open-fronted double-acting compound engine by Messrs. Matthew Paul & Co., of Dumbarton, mounted on the same baseplate with and coupled direct to a Mavor & Coulson four-pole dynamo, giving an output of 150 amperes at 100 volts, at a speed of 300 revolutions per minute. The dynamo is generally similar to those mentioned above; the armature is of the toothed core type, barrel-wound with bars. The pole faces are solid, and keep in place the field coils, which are wound on sheet steel formers with brass flanges.

The engine is adapted to work with a steam pressure of 150 lbs. per sq. in., and the cylinders are 6½ in. and 10 in. diameter × 6 in. stroke. They are supported at the back on cast-iron columns which carry the guides, and at the front on two wrought-iron columns. Both cylinders have ordinary flat slide valves. The crankshaft, piston rods, connecting rods and valve spindles are all forged from ingot steel, and all working joints and bearings are fitted with adjustable gun-metal bushes. The governor is of the crankshaft spring and ball type, and controls a balanced double-beat throttle valve, which in conjunction with a heavy fly-wheel fitted on the end of the shaft next the dynamo regulates the speed of the engine within very narrow limits.

Small Ship-Lighting Set.—One of Messrs. Drysdale's "Bon Accord" open type double-acting engines, mounted on the same bedplate with and coupled to a four-pole Mavor and Coulson dynamo, giving an output of 100 amperes at 100 volts, is exhibited at Messrs. Drysdale's stand. The engine is designed to develop 16 B.H.P. at a speed of 250 revolutions per minute, with a steam pressure of 100 lbs. per sq. in. The cylinder is 7½ in. diameter × 7 in. stroke. This set is fitted with a short cast-iron base, and the outer bearing of the dynamo is carried by a bracket supported from the magnet casting. The brushes are fixed in position, but initial adjustment is provided for by cranked spindles.

BUSINESS NOTES.

(*Continued from page* 348.)

Finsen Light for Lupus.—A correspondent of the *Daily Mail* says that Dr. Sophus Bang, manager of the laboratory belonging to Prof. Finsen, the inventor of the light cure for lupus, has constructed a special electric lamp, giving a feeble light, but one extremely rich in chemical rays. The result is that he has obtained bacteria-killing power ten times as great as can be got from the ordinary electric arc lamp. This discovery will prove of the greatest importance in the treatment of disease by light. A lupus patient, who now requires treating for 75 minutes at each operation, will only require from three to five minutes' treatment with the new lamp. The lamp is, moreover, comparatively very cheap, costing only about £3. It can be fitted to any ordinary electric light installation.

Glasgow.—An application by the Corporation of Glasgow for an interim interdict against the National Telephone Company, opening or otherwise interfering with the surface of Argyll Street and the Trongate, or laying any pipes, without the consent of the Corporation, was heard last week.

Mr. Andrews, on behalf of the defenders, said that the National Telephone Company got permission from Mr. Goldie, proprietor of subjects at the corner of Wellington Street and Argyll Street running westwards, to erect an exchange on the roof of his building, and from the Caledonian Railway Company to lay a cable inside their tunnel running along Argyll Street. In consequence of these arrangements the company had opened up the pavement and cut a hole between the wall of the tunnel and the building in order to carry the cable to the roof. A very important legal point would be involved as to what harm the Corporation had undergone in the existence of that hole. He submitted that there was no case in any shape or form for interim interdict.

Mr. Lindsay stated that it was done between a Saturday night and Sunday morning in June last. Some difficulty had been found in discovering who opened up the street. The proprietor of the property even was not entitled to open up the footpath of that street without the permission of the Corporation.

Interim interdict was granted.

At Glasgow Sheriff Court on Tuesday, the interdict granted last week was continued until the company make the necessary application for the opening of the public streets to the Corporation.

Large Order for Machine Tools.—The British Westinghouse Company have placed a contract with the Niles Tool Works for machinery to the value of 40,000 dollars to be installed in their new works at Manchester.

New Shunting Pole.—Trials are said to be in progress with a new shunting pole, generally similar to the ordinary one, but provided with a small electric lamp in a hollow in the hook; this is enclosed between red and green bull's eyes, so as to afford a means of signalling as well as giving light between the wagons for coupling, &c. A battery in the handle provides the necessary current.

Outings.—The men employed on the Broughton Section of the Salford contract, which is being carried out by Messrs. W. T. Glover & Co., Limited, had an excursion up the river on 17th inst., which passed off most successfully, and was heartily enjoyed by all.

The workers in connection with the City of Glasgow electricity department, with their friends, to the number of about 800, had their second annual outing on Saturday, when they visited Stirling. Sports were held in the King's Park during the day. At two o'clock the heads of the department, together with several members of the Corporation, sat down to dinner in the Station Hotel, under the presidency of Bailie Maclay. After dinner Councillor Paton, in giving "The Electricity Department," said that they were now on the highway of prosperity. Nothwithstanding that they had to compete with the old-established gas department, he prophesied for the department the same success that had attended every other undertaking of the Corporation. The chairman, in replying to the toast, said there was a time when they could not get enough electric current to supply the wants of the city, but now they had enough and more. They were starting the year with a surplus, but the department was increasing so rapidly that by the middle or end of the winter he believed they would find that their surplus had disappeared. Councillor Gray proposed the health of the chief electrical engineer, Mr. Chamen, who replied. A vote of thanks was accorded to Mr. Denholm for the active part he had taken in organising the outing.

Royal Elevators.—A paragraph has been going the rounds of the daily Press to the effect that a New York company is to make the electrical machinery for three elevators for Buckingham Palace. As a matter of fact, the Otis Elevator Company has received the contract.

with a flange for bolting direct to the fly-wheel of a

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Spain.—The use of the following types of electricity meters in Spain has just been approved by the Government—Schuckert, Lusesche, Thomson, and Aron.

Trade Announcements.—The business lately carried on by Mr. J. Taylor under the style of J. Taylor & Co., 1A, Dyott Street, Shaftesbury Avenue, electrical fittings manufacturers, will henceforth be continued under the name of Taylor & Co., at 105, Great Russell Street, Bloomsbury Square, Mr. J. Taylor's services having been retained as working manager.

Messrs. Johnson & Phillips inform us that Messrs. Brown & Co., of Cobden Chambers, Pelham Street, Nottingham, are no longer their agents, nor are they authorised to represent the firm in any way.

Messrs. W. E. Burnand & Co., electrical engineers, give notice of their removal from Ocean Works, 119, St. Mary's Road, to larger and more convenient premises, Lowfield Works, 428—434, London Road, Sheffield.

Messrs. W. and R. Forster have opened an office at 8, Cope Street, Dublin, as electrical engineers and contractors for all kinds of electrical work, and will be pleased to receive trade catalogues.

The Anchor Electric Company, of 39, Victoria Street, Westminster, inform us that they have taken up the manufacture of Déri's single-phase propulsion induction motors, which start with double normal torque and with moderate current. These motors start as continuous-current motors with only part of the poles excited, and are automatically switched over when full speed is reached, and continue then to run with all poles excited as single-phase motors. Such a motor was successfully tested at Islington Borough Electricity Works, and now works a lift at Leicester. There is no special starting apparatus required for this purpose, except a lever which either makes contact with a (single) forward or reversing sector, or stands between them. The speed of the motor depends on the part of the sector touched. A number of these motors are on order.

Messrs. Bergtheil & Young have ceased to represent the Mica Insulator Company, which will in future carry on business from its factory at Stansted, Sussex.

ELECTRIC LIGHT AND POWER NOTES.

Amble.—The U.D.C. has approved of an application of the Northern Counties' Electric Supply Company to the B. of T. for an electric lighting prov. order.

Ashington.—The D.C. has approved of an application by the Northern Counties' Electric Supply Company to the B. of T. for an electric lighting prov. order.

Bexley.—The U.D.C. has appointed a sub-committee to confer with Messrs. Mordey and Dawbarn respecting the proposed installation of electric light and tramways.

Bideford.—The D.C. has declined the offer of Messrs. Southam & Co. to light the town with electricity.

Creswell.—The Parish Council has accepted the offer of the Bolsover Colliery Company to supply the village with electricity, subject to the sanction of the L.G.B.

Dewsbury.—Some time ago the Corporation advertised for an engineer to take charge of the electricity works. The salary offered was £250, to be advanced to £350 at the end of 12 months. As the Corporation was not satisfied with the replies, it has decided to advertise again, and offer a salary of £300, to be increased to £350 at the end of 12 months.

Dublin.—The Commissioners of Public Works have received the authority of his Majesty's Treasury to make a loan of £254,000 to Dublin Corporation to carry out the electric lighting scheme for the Irish metropolis.

Finchley.—There have been nearly 100 applications for the post of resident engineer. The commencing salary will be £300 per annum.

Greenock.—The Committee has decided to take over the spare ground adjoining the generating station for additional buildings, and to order condensing plant, two additional boilers and some spare gear, at an estimated cost of £4,028.

Kingston-on-Thames.—The Board of Guardians have decided to fit up an electric lift at their new infirmary.

Kinning Park.—The T.C. has decided to have 15 arc lamps fitted up in the main street of the burgh, the current being obtained from the Glasgow Corporation under the recent agreement.

Leeds.—During the year ending March 25th last, the consumers of electric light in Leeds have increased from 1,393 to 1,829, equivalent to 31·3 per cent., and the lamps and other consuming devices installed, from 106,263 to 132,283, equivalent to 24·5 per cent. In their report the Lighting Committee say:—"The use of electricity as a motive power is extending, the number of motors connected to the mains at March 25th last being 86, with an aggregate of 205 H.P., an increase of more than 100 per cent. during the 12 months. The units sold were 2,520,414, compared with 2,005,840 in the previous year, an increase of 514,574 units (25·6 per cent.). The average price obtained was 4·03d. per unit, compared with 4·09d. per unit in the preceding year, and the average consumption per 35-watt lamp was 20·8 units, yielding a revenue of 6s. 11·8d. The capacity of the plant installed at the works has been increased from 3,040 to 4,020 KW., and contracts have been entered into for additional plant with an aggregate output of 4,720 KW., making a total of 8,740 KW. The abnormally high price of coal has largely increased the cost of production, which was 1·31d. per unit, as compared with 1·19d. in 1900. The capital expenditure during the year was £60,575 10s. 6d. The total receipts on revenue account were £43,669 2s. 2d. The working expenses were £13,770 3s., leaving a gross profit of £29,898 19s. 2d. After deducting interest and sinking fund, a surplus remained of £6,881 10s. 8d. Of this sum £6,000 became available for the relief of the rates.

Liverpool.—In his report on the quantity of electrical energy supplied for all purposes during July, the electrical engineer states that the amount of energy supplied to private consumers was about 50,000 units more than in July, 1900, while the quantity supplied for the tramways was upwards of 300,000 units in excess of the quantity supplied in July of last year. The large increase in the number of cars running in July of the present year as compared with July of last year, the number being 322 against 141, is the explanation of the increased consumption.

Padiham.—The D.C. is considering proposals for an electric lighting scheme.

Ryde.—The T.C. has adopted the Committee's recommendation, that Messrs. Edmundson's proposals to establish an electric supply system be accepted.

Spain.—A central electric lighting station is about to be established in the town of Cadiz.

Tyneside.—The Tyne Improvement Commissioners have decided to light the Albert Edward and Northumberland Docks and Staiths by means of electricity, and have accepted the tender of Messrs. Crompton, amounting to £6,185, for arc and incandescent wiring and fittings, to the specification of Messrs. Handcock and Dykes, their consulting engineers. The lighting of the Tyne Ferries, carried out by Messrs. Falconar, Cross & Co., of Newcastle, under the same engineers, has just been completed.

Umtali (Rhodesia).—On Saturday, August 3rd, the official opening of the electric power plant took place at the Rezende Mine, 10 miles from Umtali, the first mine in Rhodesia to utilise water-power in this manner. Additional power will enable the mine to run more stamps, besides lighting the mine with electricity.

Walsall.—The L.G.B. has sanctioned the borrowing by the T.C. of a further sum of £3,000 for electric lighting.

Whitby.—At a special meeting of the U.D.C. last week a sub-committee recommended that the Council should appoint either Mr. Senior or Mr. W. E. J. Heenan as resident electrical engineer. Messrs. Preece & Cardew, the consulting engineers, however, urged that Mr. Kennaway should be appointed, and a resolution to this effect was carried by the casting vote of the chairman.

ELECTRIC TRACTION NOTES.

Blackburn.—On Saturday afternoon a temporary stoppage of the electric cars on the Church Street route, Blackburn, was caused by the breaking of a trolley when the car was rounding a curve.

Bradford.—Two new sections of electric tramways have just been completed at Bradford—the Idle and Thackby sections—and the workmen have this week been turned on to the electrification of the old lines. The Corporation have power to spend £453,168 on 14 new sections. They are accumulating all sorts of material for the work, and have 230 more cars either on order or about to be contracted for. In the relaying of lines with a busy traffic, the use of a temporary movable track is proving of the greatest service.

The Tramways Committee is considering a plan for watering the streets by means of a tank car running on the electric tramway routes. It is also proposed to utilise the tramways for removing refuse.

Bristol.—The Labour demonstration of Saturday last attracted 20,000 persons. It was not solely connected with the dispute between the Unionists and the Bristol Tramway Company, but the paid-off men marched in procession and collected money to augment the allowance paid them each week by the Gas Workers' Union. A number of minor accidents have occasioned brief interruptions in the service of electric cars since the one already reported as having occurred in Hotwell Road. In the minds of a section of the public, these accidents, coupled with the singular freedom from mishaps in working the electrical cars in the past, have been associated with the employment of a large number of fresh drivers in the place of those paid off. Several other Trades Unions have encouraged the paid-off tramway men by resolutions and grants. The trades unionists are running brakes in working-class districts to compete with the electric cars. In most parts of the city, passengers on the cars seem, however, as numerous as ever.

Buenos Ayres.—According to the *Review of the River Plate*, the Chamber of Deputies has approved the project of Messrs. Quesada Bros. for the construction and working of an electric tramway, starting from Parque Lezama, crossing the Riachuelo and passing through Barracas al Sud, Lanús, Lomas and Almirante Brown. The concession to be in perpetuity.

Dudley.—The Tramways Committee of the Corporation have now before them for the third time a scheme for the establishment of a central terminus for the principal electric tramlines. The British Electric Traction Company have agreed to pay a sum of money for the use of a space in the Market Place. They propose to lay on this space two short loops, or "push-ins," also to construct a "turn-out" in the centre of High Street and extend the double line to St. Thomas's Church. This will enable the company to run the cars from Cradley Heath and Kingswinford right into the Market Place.

Dundee.—Last week an accident took place on the Lochee route. As one of the electric trolleys was going up Lochee Road, Harry Crockett, six years of age, ran in front of it. He was knocked down and badly crushed, and it was found that in addition to bruises on head and legs, the boy was suffering from serious internal injuries.

Epping Forest.—The Woodford U.D.C. has received an intimation from the Metropolitan Tramway and Omnibus Company, who are the promoters of the proposed electric tramway system to connect the Epping Forest district with the City, that the portion of their scheme relating to Woodford and Wanstead has been abandoned.

Germany.—An electric railway for the transport of goods only is being constructed between Ober-Schönweide and Rummelsberg, near Berlin.

Glasgow.—The traffic receipts of Glasgow Corporation tramways for the week ending August 17th, 1901, were £12,516 16s. 11d., compared with £9,788 0s. 2d. for the same period last year.

The receipts for the week ending August 24th, 1901, were £13,424 0s. 10d., compared with £8,866 11s. 10d. for the corresponding week last year. This forms a new record. Since June 1st, 1901, the beginning of the financial year, £147,205 19s. 10d. has been drawn, against £114,946 13s. 4d. This increase may be partly due to the Exhibition, the attendance at which totalled last Monday 6,073,845.

Halifax.—There is great dissatisfaction at Halifax about the conditions under which some of the electric tramway services are being run, and also as to the financial results of the recent working, and loud allegations are made of bad corporate management. The latest report of the traffic receipts for a fortnight shows a return of £115 per mile for the 25 miles of tramways, as against £168 per mile earned on the 12 miles of tramways which were being worked during the corresponding fortnight of 1900.

During a heavy thunderstorm on Sunday evening last, a tramcar on the Halifax and Luddenden-foot section was struck by the lightning, and the motors disabled. The driver, who had hold of the lever, was knocked down, but was not otherwise injured. The overhead equipments were disturbed in other parts of the district, and traffic considerably interrupted.

Leicester.—The Tramways Company has accepted the offer of the Corporation to purchase the undertaking for the sum of £134,100.

Liverpool.—The publication of Councillor T. Utley's letter on the management of the Liverpool electric tramways, to which reference was made last week, has given rise to a warm and animated controversy in the local press. Mr. R. W. Blackwell has written on behalf of his company, showing that the statements of one anonymous correspondent, affecting work which the company carried out, were entirely erroneous. The overhead construction, Mr. Blackwell stated, was originally designed to be operated on the usual English side-running system, the trolleys being supplied with "swivelling" heads. Since the overhead line has been handed over to the Corporation, for reasons of which Messrs. Blackwell had not been informed, it had been decided to change the system to fit the American method of running with a fixed head. Certain alterations in the type of fittings had consequently been made. The wire employed throughout the Liverpool system was, he said, of a much larger size than that generally used for trolley lines, and was of the very finest hard drawn copper by the best makers. A very large proportion of it was manufactured and supplied by Messrs. Frederick Smith & Co., of Manchester, and samples of the wire were from time to time tested and approved of by the late Dr. John Hopkinson and other authorities. The criticisms of the different correspondents are almost entirely criticisms of the policy of the Tramways Committee. Mr. F. Dresser, a mill proprietor of acknowledged engineering ability, complains of the cost of working the system by the Corporation. Mr. Dresser points out that some of the generating stations are driven by non-condensing engines, and that others which have condensing engines use the town water at 6d. per 1,000 gallons for condensing. Another critic speaks of the deputation which went from the Liverpool City Council to view cars of German make at Hamburg, as having, during a 15 minutes' inspection in Hamburg, come to a conclusion which meant the saddling of the "groaning ratepayers of Liverpool with £15,000 worth of unsaleable souvenirs from Germany, to which must be added £4,000 or £5,000 for maintenance and repairs." As a set-off to this unfavourable criticism, it may be mentioned that during the last 12 months, no fewer than 33 deputations from other towns visited Liverpool and inspected the electric car system with a view to the adoption of electric traction in their own towns. The construction of tramways for an electric car service between the southern terminus of the Liverpool system and the town of Garston, three miles beyond that terminus, is being steadily pushed on. The work is being carried out by the British Insulated Wire Company and is expected to be finished before Christmas.

Manchester.—The Tramways Committee are having a difficulty with their employés as to the terms of service. The Committee deny the right of any trades union to dictate to them, but they have decided to hold a meeting, at which the views of the men will be laid before them.

Margate.—An electric tramcar at Margate went wrong on Saturday, and an accident was narrowly averted. The driver lost control of the car as it reached the top of Paradise Street, a particularly steep hill, through the trolley coming off the overhead wire, and it ran back on to the parade. Several passengers jumped off, one lady being badly cut about the face and head. A gentleman was severely injured, and others were more or less seriously hurt. The car was pulled up on the level road just in time to avoid a crash into another car which was on the point of following up the hill.

Middlesex.—In our issue of 26th ult., we reported that the Finchley D.C. appealed to the B. of T. against the confirmation of the order of the Light Railways Commissioners, giving the County of Middlesex power to make light railways over the Great North Road, on the ground that the Commissioners decided that the County Council's scheme should be carried out without hearing the Finchley authorities on the scheme within their own boundaries. The B. of T. have replied as follows:—(1) The appeal of the Finchley Council against the rejection of their application for an order by the Light Railway Commissioners is dismissed; (2) The alleged informality of the application by the Middlesex County Council has not been sustained; (3) As to whether the proposals of the Middlesex County Council ought to be submitted to Parliament, the Board decide this question in the negative. The Finchley U. D. C. has referred the matter to the Tramways and Electric Lighting Committee.

New Zealand.—Pahiatua is to have an electrical railway at a cost of £200,000.

Sedgley.—On Saturday last the British Electric Traction Company commenced running cars on the line from the tramway depôt, Upper Gornal, to the Bull Ring, Sedgley. The line had been closed for some time for reconstruction and electrical equipment.

Spen Valley.—An important conference will be held on September 10th, at Batley or Dewsbury (says the *Daily Mail*) in connection with the Spen Valley Light Railway scheme, which, when carried into effect, will provide the "heavy woollen district" with electrically-equipped tramways. The British Electric Traction Company has already obtained the necessary power from the B. of T. to construct the line, but before proceeding with the work it has to agree with the local authorities as to certain details. When completed, the tramway line will run round a thickly-populated district 40 miles in circumference, joining Bradford, Leeds, Halifax, Huddersfield and Wakefield. It embraces such places as Dewsbury, Ravensthorpe, Batley, Cleckheaton, Gomersal, Thornhill, Liversedge, Hunsworth, Gildersome, East and West Ardsley, and Morley. All the local authorities have already come into line with the company except the Batley Corporation, which has a scheme of its own. The only tramway running in the district is that belonging to the Dewsbury, Batley, and Birstal Tramway Company, and the Batley Corporation proposes to buy up the line of this company, or so much of it as runs within its own district. It cannot purchase the whole of the line because one end of it is in the Dewsbury district and the other in that of Gomersal, and in each of these cases the local authority will purchase the line and subsequently lease it to the British Electric Traction Company. One of the points in the agreement between the company and the authorities is that the former shall take its current from as many of the latter as can supply it.

Stalybridge.—The Joint Corporations of Mossley, Hyde, Stalybridge and Dukinfield, have obtained an Act to carry out a scheme of electrical traction and lighting. The first meeting of the newly-constructed board will be held at Stalybridge on September 6th.

Taunton.—The electric trams commenced running on Wednesday, August 21st, in Taunton, for the use of the public. The B. of T. had not given their final certificate, but pending the receipt of this, the company was granted permission to commence the service.

Stockport.—The new electrical tramways which have been constructed by the Corporation of Stockport, were opened on Monday with a public ceremony. The Mayor of Stockport and members of the Town Council, &c., met at the new electric car sheds in Wellington Road to inaugurate the service. In commemoration of the event Alderman Atherton, as chairman of the Tramways Committee, was presented with a handsome silver flower bowl by Mr. Leonard Coope, on behalf of the contractors for the works. The party then boarded the cars, which proceeded to

The average price obtained was 4·03d. per unit, compared with 4·09d. per unit in the preceding year, and the average consumption

to compete with the electric cars. In most parts of the city, passengers on the cars seem, however, as numerous as ever.

Woodley, three miles distant. On their return luncheon was served at the Wellington Street car shed, the Mayor of Stockport presiding. Sir Joseph Leigh, M.P., proposing the toast of "The Stockport Corporation Tramways," remarked that the new electric tramway service would provide a connecting link between the outside districts and the traders of the town, which was of vital importance.

In responding to the toast, Alderman Atherton said the average cost of the double line of track had been £12,944 per mile, and of the single track about half of that. The cars had cost about £700 each, and the overhead equipment £1,389 per mile. The Tramways Committee had a good deal of work yet to do.

The route opened on Monday consists of three miles of single and double track out of a total length of over nine miles, for the construction of which power was obtained last year, the estimated cost being £181,000, including permanent way, cars, and shed. The line which has been opened extends to Woodley. Another length from the boundary of Stockport to Redditch is being constructed. The contract for the cars was placed with Messrs. Dick, Kerr & Co., of Preston, 25 cars of the Liverpool type being ordered. Owing to the steep gradients in Stockport, two motors of 30 H.P., instead of the usual 25-H.P. motors, are fitted to each car. The weight of each car will be 10 tons, and each will carry 56 passengers, 22 inside and 34 outside. Electrical energy will be supplied from the generating station of the Corporation in Mill Gate. The new car shed in Wellington Street, to accommodate the 25 cars, has cost £5,000. Four other routes have to be constructed to complete the system, and these are expected to be finished in about 12 months.

TELEGRAPH AND TELEPHONE NOTES.

Canadian Telegraphs.—The Canadian Government system of telegraphs has just been completed to Chateau Bay, 1,100 miles below Quebec. The cable connecting the telegraph line with Belle Isle light station, off Labrador, will be laid by September 15th. The Marconi apparatus will be installed on Bell Isle, so that passing vessels which are properly equipped may be communicated with in the event of a break in the cable.

Fatality.—On Wednesday last week a squad of four telegraph linesmen in the employ of the Glasgow and South-Western Railway Company were up a pole, cutting the wires preparatory to taking down the pole, when all at once the pole broke near the ground. J. Haggerty, foreman of the squad, and a man named Younger endeavoured to jump clear of the falling pole, but in doing so both sustained serious injuries. J. Dollan, labourer, and G. Hutcheson fell with the pole, and the former was killed. Hutcheson had his right arm fractured and his head bruised, and sustained internal injuries.

Glasgow.—The Corporation Telephone Exchange was to be formally opened yesterday by the Right Hon. R. W. Hanbury, Secretary to the Treasury.

High Wycombe.—The Corporation has appointed a committee to consider the advisability of establishing a system of municipal telephones.

The Pollak-Virág Telegraph.—Advices from Budapesth state that the projected trials of this system between Paris and Lyons were abandoned on account of the expense involved. The Telegraph Administration of Hungary has, however, installed the system on a working line between Fiume and Buda-pesth, a distance of 375 miles. On this line a practical working speed of 40,000 words per hour is obtained. The French Government has been asked to give the invention a trial. The German Government is about to undertake a practical trial between Berlin and Cöln. Many improvements have been made recently in the apparatus, and more especially in the perforator used for preparing the sending ribbons.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899	
Para-Maranham	March 1, 1900	
Cayenne-Pinheiro	April 20, 1901	August 26
Basseterre-Les Saintes	June 29, 1901	
Nase-Keelung (Formosa)	Aug. 2, 1901	
Cadiz-Teneriffe	Aug. 6, 1901	
Bissao-Bolama	Aug. 16, 1901	
Trinidad-Demerara	Aug. 26, 1901	
Landlines :—		
"Via Hanekin" on Persian territory	Feb. 24, 1900	
Pekin-Kalgan	June 14, 1900	
Maimatchin-Kalgan	June 30, 1900	
Communication with Baranquilla and Cartagena	Dec. 8, 1900	
" towns of Venezuela	Oct. 31, 1900	
Guantanamo-Baracoa	Aug. 22, 1901	August 26

New Submarine Cable.—The Great Northern Telegraph Company has decided, with the financial assistance of the Northern Kingdoms, to lay a cable from the Shetland Islands, *viâ* the Faroës, to Iceland. The reason for laying this new cable is the desire to determine more accurately beforehand the weather in Western Europe, which is chiefly influenced by depressions coming from the North-West of the British Isles. By means of a telegraphic connection with Iceland, the European Weather Bureaux will, it is believed, be able to predict approaching depressions and consequent changes in the weather.

Rochdale.—Messrs. Bennett & Ward-Thomas, of Manchester and Westminster, have been appointed by the Corporation to report on a municipal telephone exchange.

Telephone Trunk Service.—In reply to a letter from the Associated Chambers of Commerce with regard to delay in telegraphic and telephonic messages, the Postmaster-General stated that with the object of securing the greatest efficiency, he had recently appointed two experts of great experience, whose duty it was to examine the working of the telegraphs at all the large offices, and to take measures for effecting any necessary improvements in the service. Every endeavour was made to keep pace with growth of traffic, which had been particularly rapid in the case of the telephone trunk service, and a large number of additional trunk circuits had been erected, or were in course of erection. It had, however, not been practicable to make such progress as could be desired, owing partly to the difficulty experienced in many directions of obtaining the necessary wayleave facilities, and partly to the lack of an adequate supply of skilled labour.

Telephonic Communication between England and Belgium.—Telephonic communication between England and Belgium is about to be established by means of a 4-core submarine cable 50 knots long, the conductors of which weigh 160 lbs. per knot, and the gutta-percha insulation 300 lbs. per knot. The land lines will be of copper, weighing 800 lbs. per mile.

Turkey.—The *Levant Herald* states that the Turkish Administration of Posts and Telegraphs is about to renew the submarine cable between Rumeli and Anatol Hissar.

Wireless Telegraphy.—With a flourish of trumpets the *Daily Express* announces a revolutionary discovery in wireless telegraphy, made by Mr J. N. Maskelyne, "son of the Egyptian Hall expert, and himself a very clever illusionist." The inventor, we are informed, has been for some months experimenting in the artillery grounds at Shoeburyness; he uses the closed circuit, and it is said that with this he has maintained communication for some weeks with another station at the North Foreland, 30 miles away. We await further disclosures with interest.

The Dover Chamber of Commerce has decided to again petition the Trinity House authorities to replace on the Goodwin Lightship the wireless telegraph apparatus which was removed about a year ago. The installation proved of enormous value when vessels got on the Sands.

CONTRACTS OPEN AND CLOSED.

OPEN.

Amsterdam.—September 2nd. Tenders are invited by the Municipality of Amsterdam for the supply of electric cars, 5,000 tons of rails, &c. Director of the Municipal Tramways, Nieuwe Achtergracht, No. 164, Amsterdam.

Aston Manor.—September 4th. Water-tube boilers, 200-KW. and 500-KW. steam dynamos, balancer, switchboard, crane, and arc lamps for the D.C. electricity works. See "Official Notices" August 9th.

Aston Manor.—September 4th. Pipework, fitters' shop and cables for the municipal electricity works. See "Official Notices" August 16th.

Batley.—September 14th. The Corporation is advertising for tenders for all materials for the permanent way of 3½ miles of electric tramway in the borough.

Belfast.—August 30th. Cast-iron frames and covers, pipes, and bell mouth ends for the municipal electricity department. See "Official Notices" August 16th.

Bournemouth.—August 31st. Tenders for water cooler and travelling crane for the Corporation tramway station. See "Official Notices" August 16th.

Bournemouth.—September 16th. The Town Council wants tenders for tramway rails, permanent way construction and rail bonding, and paving. See "Official Notices" August 23rd.

Bournemouth.—September 17th. The Town Council wants tenders for steel rails, permanent way construction on the conduit system, ploughs, &c., and paving. See "Official Notices" to-day.

Doncaster.—August 31st. The Corporation invites tenders for the supply and erection of a tramway switchboard. See "Official Notices" August 23rd.

Doncaster.—September 14th. The Corporation invites tenders for tramway poles and overhead construction. See "Official Notices" to-day.

Dundee.—September 14th. The T.C. invites tenders for overhead equipment for new tramway routes. See "Official Notices" August 23rd.

Edinburgh.—September 9th. For the electric lighting installation for the second portion of the Colinton Mains Fever Hospital (800 points), for the Corporation. See "Official Notices" August 9th.

Egypt.—September 15th. According to the *Board of Trade Journal* the Local Committee at Fayoum have decided to instal the electric light in the town. Persons wishing to tender can obtain the conditions of contract from the Minister of Public Works at Cairo.

France.—August 30th. Tenders are being invited until the 30th inst. by the French Post and Telegraph authorities in Paris, for the supply of 420,000 porcelain insulators. Tenders are to be sent to Le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris, whence particulars may be obtained.

Glasgow.—August 30th. The Corporation wants offers for the supply, delivery, and erection, complete, of the overhead trolley constructional work required for the extension of the system. Mr. John Young, general manager, 88, Renfield Street, Glasgow. A Bank Draft for two guineas, with application for specification.

Kingston-upon-Hull.—September 26th. The Corporation wants tenders for two high speed three-crank 800-I.H.P. compound engines and four Lancashire boilers. See "Official Notices" to-day.

Kirkcaldy.—September 13th. The Corporation wants tenders for the supply and erection of overhead construction for electric tramways. See "Official Notices" August 23rd.

Kirkcaldy.—September 16th. The Corporation wants tenders for the supply and erection of arc lamp-posts, brackets, and switch-boxes. See "Official Notices" to-day.

Lowestoft.—September 9th. 500-KW. steam dynamo, switchboard panel, &c., for the municipal electricity works. See "Official Notices" August 16th.

Manchester.—September 14th. The Tramways Committee wants tenders for trolley wire and overhead line materials. See "Official Notices" to-day.

Mansfield.—September 5th. Refuse destructors for the E.L. Committee. See "Official Notices" August 2nd.

Middlesbrough.—September 3rd. Mechanical coal-handling plant for the electricity works. See "Official Notices" August 2nd.

Newport (Mon.).—September 4th. Telephones, electric bells, &c., for the new workhouse. See "Official Notices" August 16th.

Oldham.—September 10th. The Corporation wants tenders for two overhead electric travelling cranes. Particulars from Mr. A. Andrew, Gas and Water Offices, Oldham.

Oldham.—September 10th. Two electric travelling cranes for the Greenhill electricity works. See "Official Notices" August 16th.

Partick.—12 months' supply of arc lamp carbons, meters, demand indicators, and house fuse boxes for the T.C. See "Official' Notices" August 16th.

Poplar.—September 18th. The Borough Council wants tenders for multiple core lead-covered cables and accessories. See "Official Notices" to-day.

Salford. — September 14th. The Health Committee wants tenders for a 55-KW. steam dynamo. See "Official Notices" to-day.

Southend-on-Sea.—September 7th. The Corporation wants tenders for supplying and laying electric lighting cables. See "Official Notices" August 23rd.

Spain.—The Junta Local de Prisiones de Madrid, is inviting tenders until the 31st inst., for an installation of electric lighting in the Cellular Prison in Madrid, and for the working of the same. Particulars may be obtained from, and tenders are to be sent to, La Secretaria de la Junta Local de Prisiones de Madrid, at the Prision Celular, Madrid.

Sunderland.—August 30th. The Corporation wants tenders for wiring the new (Hylton Road) electricity works. See "Official Notices" August 23rd.

Torquay.—September 13th. The E.L. Committee invites tenders for the supply of arc lamp carbons for a period of 12 months from October 1st, 1901. See "Official Notices" August 23rd.

Walthamstow.—August 30th. The U.D.C. invites tenders for house wiring. See "Official Notices" August 23rd.

Whitehaven.—September 16th. The Corporation wants tenders for the supply of incandescent lamps for six months. See "Official Notices" to-day.

Willesden.—The D.C. wants tenders for the equipment of the proposed electricity works. See "Official Notices" August 2nd.

CLOSED.

Bushey.—The contract for the supply of a storage battery to the Royal Masonic Institution for Boys, Bushey, Herts., has been awarded to the Hart Accumulator Company.

Great Northern and City Railway.—The contract secured by the British Thomson-Houston Company, Limited, for the electrical equipment of the Great Northern and City Railway is to provide sufficient apparatus for the operation of a three-minute service between Finsbury Park and Moorgate Street. Each train consists of seven cars, the two end cars and the centre car being equipped with motors; the schedule time for the journey of seven miles is 13½ minutes, allowing for three intermediate stops of 20 seconds each. The weight of the train will be approximately 200 tons.

This road will be of more than ordinary interest, from the fact that it is the first electric railway in Great Britain to be operated entirely on the train control system.

Boiler Plant.—The exact number and type are not yet fully decided upon. The boilers will be fed by three vertical duplex pumps, and the feed water heater (vertical) will have a capacity of 7,500 gallons per hour. The economiser will consist of 480 tubes arranged in sections 10 tubes wide. All the steam pressure piping will be of heavy lap-welded pipe, tested to 500 lbs. per square inch.

There will be a Hunt coal conveying plant of the noiseless automatic gravity bucket type, sufficient to handle 30 tons of coal per hour. There will also be two vertical three-throw single acting lifting pumps, a storage tank of 21,000 gallons capacity, water-softening plant to treat 8,500 gallons per hour, and two receiving tanks, each of 4,700 gallons capacity. The economiser, stokers, conveyor, and lifting pumps are all to be operated by electric motors.

Engines.—There will be four vertical cross-compound condensing Musgrave engines, developing 1,250 I.H.P. as a normal load, and 1,875 I.H.P. as a maximum when running at 100 r.p.m., and working with a steam pressure of 150 lbs. per sq. in., each engine being arranged to drive an 800 KW. generator, which will be mounted on the main crankshaft between the engines. The specifications call for a speed variation of not more than 2½ per cent. either way between full load and no load. There will also be two vertical tandem compound non-condensing auxiliary engines, capable of developing 83 I.H.P. continuously. The condensing plant will consist of four surface condensers, with combined air and circulating pumps. The engine room will be provided with a 30-ton overhead travelling crane, operated by three electric motors.

Generators.—There will be four main generators of the standard Thomson-Houston railway type, having 14 poles, and a capacity of 800 KW., voltage 525 no load, 575 full load, when running at 100 r.p.m. There will be two auxiliary generators of the same type, each of 50 KW. capacity, voltage 550 no load, 575 full load, running at 400 r.p.m. These two generators are intended to supply current for the lighting and power required at night for the stations and repair shop tools, &c., when the main generators are shut down.

Switchboard.—The switchboard will consist of four main generator panels, four main feeder panels, two auxiliary generator panels, three auxiliary power panels, three auxiliary lighting panels, and voltmeter equipment. These panels will be equipped with magnetic blow-out circuit breakers, Thomson astatic instruments, wattmeters, switches, &c., all of the B.T.H. standard pattern.

The third rail is to be of channel section, weighing 80 lbs. per yard. The resistance of the material is specified not to exceed 0·32 ohm per mile per sq. in. of cross sectional area. The bonds will be of the copper plastic type, and the rails will be supported every two yards on porcelain insulators of the double petticoat type. At intervals the collector rails of the up and down tracks will be interconnected, an automatic circuit breaker being placed in each inter-connecting circuit, so as to enable either rail to be isolated from the other when desired.

Motor Cars.—There will be 36 motor cars, each mounted on two 4-wheel trucks, each truck carrying one Thomson-Houston G E-66 geared motor, and each car will have four collector shoes, and the usual controllers, circuit breakers, &c., making complete motor car equipment. The brake equipment will be of the Christensen type.

Repair Shop.—The repair shop is to be equipped with lathes, wheel press, drilling machines, shaping machines, &c., all driven by an electric motor.

Mansfield.—The Council, at their meeting on Friday, the 16th inst., on the advice of Mr. Robt. Hammond, accepted the tenders of the firms named in this column last week. The following are the amounts quoted:—

Section A, boiler house plant, J. Musgrave & Sons, Limited, £3,162; Section B, engine house plant, Thos. Parker, Limited, £6,180; Section C, condensing apparatus, Johnson & Phillips, £725; Section D, switchboard, Bertram Thomas, £1,462 14s. 3d.; Section E, accumulators, Tudor Accumulator Company, Limited (with 100 per cent. capacity maintenance guarantee), £2,987; Section F, overhead crane, Carrick & Ritchie, £316; Section G, mains, Western Electric Company, £8,895 11s. 11d.; Section H, public lighting, Gilbert Arc Lamp Company, Limited, £428 14s.; Section I, meters, Chamberlain & Hookham, £768 15s.; Section K, workshop equipment, Britannia Company, £336 3s. 11d.

Nottingham.—Messrs. Dick, Kerr & Co., who are supplying most of the Nottingham electric cars, have obtained a conditional contract for the permanent way and the electric equipment of the tramways to be constructed at Ilkeston.

FORTHCOMING EVENTS.

Tuesday, Wednesday and Thursday, September 3rd, 4th and 5th.—The International Engineering Congress at Glasgow. For details of papers, &c., see ELECTRICAL REVIEW "Notes," August 9th.

Wednesday, September 11th to 18th.—Glasgow. Annual Congress of the British Association for the Advancement of Science.

believed, be able to predict approaching depressions and consequent changes in the weather.

Hospital (800 points), for the Corporation. See "Official Notices" August 9th.

NOTES.

An American "Underground."—It seems that we are not alone in the possession of an underground railway which is notorious for its mephitic atmosphere and infernal temperature; according to the American journals the grand jury of New York County has carried out an investigation of the unhealthy condition of the New York Central Tunnel, through which an exceedingly dense traffic is carried on by means of steam locomotives. In all 530 trains per day traverse the tunnel, says our New York namesake; the total length of the tunnel and its approaches is about two miles, and the time taken to pass through it—when trains are not blocked in it—is from 3½ to 5 minutes. The temperature in the cars often exceeds 100° F., and the atmosphere becomes so foul that the passengers have at times lost consciousness during the transit!

The jury decided—not unreasonably—that the matter constituted a public nuisance, and recommended that vigorous action should be taken to abate it; further, they recommended that the brick walls which at present divide the tunnel into three parts should be replaced by steel columns and girders; that the cars should be protected from the heat of the sun when standing above ground; and that some other motive power should be substituted for steam haulage.

The most astonishing feature of the affair, to our mind, is the declaration of the railway engineers that electric traction in the tunnel is impracticable! That such a proposition should be put forward, in New York, in the 20th century, is almost incredible. We can understand that the directors should be unwilling to incur the heavy expense of the conversion to electric haulage; but that they should attempt to evade their responsibilities by saying that it *cannot* be done is too absurd. The directors of our own "Drain" confess that they cannot adopt electric traction on their system without financial assistance; but they do not talk nonsense about impossibilities.

While on this subject, we may refer to an ingenious, if flighty, suggestion which recently appeared in the *Lancet*—namely, that by means of electricity obtained from dynamos carried on the carriages of the Underground trains, ozone may be generated and employed to purify the air. This is all very well; as the *Daily Telegraph* playfully suggests, a trip round the Inner Circle might, under such conditions, take the place of a week-end at Brighton! But it must be borne in mind that one cannot generate ozone (which the *D.T.* aptly styles "a sort of oxygen in high spirits") without oxygen; and until the Inner Circle is electrified, and no longer requires ozonising, we fear the necessary oxygen will continue to be wanting.

British Submarines.—In an interview with the *Westminster Gazette*, Lieut. Trevor Dawson, who is in charge of the construction of the five submarine vessels at Barrow, stated that the first would be finished and ready to launch by the end of next month; the lieutenant is confident that they will prove as good as any similar vessel yet constructed. While their speed was but 7 or 8 knots at present, he anticipated that, as in the case of the Whitehead torpedo, this would be greatly improved upon, and he considered that there was a great field for development in connection with the storage battery.

New Airship for the War Office.—The *Express* announces that the War Office has ordered the construction of an airship on the Barton system, 200 ft. long, and provided with 72-H.P. engines. Mr. F. L. Rawson and Mr. W. G. Walker, it is said, are engaged upon the mechanism of the vessel.

The Trades Congress and the A.S.E.—The annual meeting of the Trades Congress will be opened on Monday next at Swansea; but the Amalgamated Society of Engineers, which has not got over its resentment on account of the censure and two years' suspension passed upon it by the Congress in 1898, will not be represented in the Parliament of Labour.

Personal.—Mr. J. B. Atherton and Mr. Jacob Atherton have resigned their posts as directors of the South Lancashire Electric Traction and Power Company, Limited, the South Lancashire Tramways Company, Limited, and the Lancashire Light Railways Company, Limited.

Mr. C. W. Kennaway, A.M.I.E.E., of Messrs. Preece and Cardew, and late chief assistant at Hastings, has been appointed resident electrical engineer to the Whitby Urban District Council.

Mr. William Morrison, the present manager of the Sunderland Corporation Tramways, who has just tendered his resignation to that body, has been appointed to the management of the British Electric Traction Company's affairs in the North of England. Mr. Morrison's new position is practically that of adviser to the various companies which are embraced in the parent company, and his district will embrace the whole of the northern counties, and the South of Scotland as far as Stirling.

Mr. J. Newman, late works foreman of Wigan Electricity Works, was on Thursday last week the recipient of a handsome presentation, on the occasion of his leaving, in order to take up a position with Messrs. Babcock & Wilcox, Limited. On behalf of the staff, the presentation was made by Mr. P. T. White.

Mr. H. Scholey, who until recently represented Messrs. Mather & Platt in London, has resigned his appointment, to join the staff of Messrs. Dick, Kerr & Co., Limited.

Appointments Vacant. — An electrical engineering assistant is wanted for the Central Technical College, at a salary of £125 per annum. The Nuneaton Urban District Council has a vacancy for a resident electrical engineer. The Salford Corporation wants two engineers in charge, at £150 per annum. See "Official Notices."

Post Office Telegraphs.—The forty-seventh annual report of the Postmaster-General, for the year ended March 31st, 1901, shows that 89,576,961 telegrams were handled during the year, a decrease of 0·92 per cent. The number of inland telegrams also diminished, by 1·30 per cent. The average value of an inland telegram was 7·40d., as compared with 7·44d. last year, and the revenue decreased 1·83 per cent. Foreign telegrams show an increase of 1·58 per cent., attaining to a record total of 7,641,090.

The number of post offices open for trunk telephone business was 312, and 17,950,296 messages were sent—representing half as many transactions—an increase of 10·87 per cent. The revenue increased 10·18 per cent., and the average value of each transaction was 5·64d.

There will be about 40 exchanges in the London telephone area; the greater part of the underground work in the City has been completed, 160 miles of pipes having been laid. About 110 miles of pipes have been laid in other districts. The royalty paid during the year by the National Telephone Company was £140,448.

Power Mains.—A very important report has been issued by the Electrical Power Mains Regulations Committee of the London Chamber of Commerce (Electrical Trades' Section). This Committee was appointed in February last to consider what modifications in the existing regulations of the Board of Trade are desirable, in view of the passing of the Electric Power Acts in the Session of 1900. Mr. R. Percy Sellon was chairman, and the remaining members of the Committee were Messrs. A. Siemens, W. L. Madgen, S. Z. de Ferranti, F. E. Gripper, A. J. Lawson, E. Manville, C. H. Merz, A. M. Sillar, C. P. Sparkes, J. J. Steinitz, A. Campbell Swinton and E. G. Cruise (technical secretary). The Committee considered eight main questions, and held numerous meetings; finally they concluded that some modification of the existing regulations was desirable, and in June last a memorandum of their views was forwarded to the Board of Trade. In brief, the Committee submits that pressures up to 20,000 volts should be permitted; that limitation of the size of mains, or their capacity, is unnecessary and undesirable; that the regulations as regards the laying and protection of underground cables should be elastic, to permit of free development,

tery to the Royal Masonic Institution for Boys, Bushey, Herts., has been awarded to the Hart Accumulator Company.

of the British Association for the Advancement of Science.

and that the thickness of the dielectric should be left to the undertakers and cable makers; and that permission to use overhead wires outside crowded city areas is vital to the commercial success of large power distribution schemes. To fortify their arguments, the Committee in an Appendix reproduce extracts from the regulations in force in Switzerland, Germany, France, and America.

The extreme importance of this matter, not only to the electrical industry, but to the whole of the manufacturing industries of this country, is obvious; above all, we think it is essential that overhead lines at high pressure be permitted, as in other countries, and we feel confident that the Board of Trade will recognise this fact. The questions of dielectric thickness and the limitation of the power carried by any one main are also of pressing urgency, for the time is approaching when the cables must be put in hand. We trust, therefore, that the Board of Trade will favourably consider the report of the Committee, and that new and liberal regulations may take the place of the present code, which is well enough for small undertakings, but is quite incompatible with the conditions of the large schemes sanctioned by Parliament.

Farnworth.—The new electric lighting and tramway power station was to be formally opened by the District Council on Wednesday last. Messrs. Lacey, Clirehugh and Sillar designed the installation, which has an initial capacity of 360 KW.

NEW COMPANIES REGISTERED.

Mica Insulator Company, Limited (71,171).—This company was registered on August 20th, with a capital of £20,000 in £10 shares, to carry on the business of manufacturers, importers and exporters of and dealers in paints, varnishes, paper cloths, papers, electric, magnetic, galvanic and other apparatus and machinery and appliances of all kinds, electrical and general engineers, makers of mica, micanite, asbestos goods and insulating materials, suppliers of electricity, &c. The first subscribers are:—E. Munsell, Hotel Metropole, W.C., mica merchant, with four shares; H. G. H. Nevill, 38, Norfolk Road, Dalston, draughtsman, with two shares; Miss M. A. L. Nevill, 38, Norfolk Road, Dalston, with two shares; E. L. Carsons, 125, Dunstan's Road, East Dulwich, clerk, with two shares; Caroline I. Ballard, 5, Cranwich Road, N., clerk, with two shares; A. B. Day, 107, Park Lane, Clissold Park, N., gentleman, with two shares; and S. G. Leach, 132, Kensington Avenue, East Ham, electrical engineer, with two shares. No initial public issue. The number of directors is not to be less than three nor more than eight; the first are E. Munsell, L. W. Kingsley, F. Brooks, A. H. S. Dyer, A. Bergtheil, H. W. Young, E. Bergtheil and R. O. Ritchie; qualification, £1,000.

South of England Development Company, Limited (71,175).—This company was registered on August 20th, with a capital of £1,000 in £1 shares, to undertake and carry out enterprises of every description, to establish and maintain electric and other trams and railroads, to build and deal with motors, cycles, and carriages of all kinds, and to carry on the business of electricians, contractors, shipowners, electrical engineers, metal founders, smiths, wire drawers, tube makers, rubber manufacturers and merchants, oil refiners, galvanisers, tool makers, colliery owners, carpenters, builders, commission agents, &c. The first subscribers (each with 25 shares) are:—J. M. Brown, 80, Pearl Buildings, Portsmouth, agent; R. H. B. Brown, jnr., Clun House, Surrey Street, W.C., accountant; W. S. Brewer, 34, Clarendon Road, Southsea, refreshment contractor; H. F. Byerley, 3, King's Terrace, Southsea, refreshment contractor; H. C. Cooke, Brooklyn Lodge, Barnes, merchant; P. Gaskell, Albert Chambers, 11, Carr Lane, Hull, contractor; P. H. Goodman, The Ferns, Kingston Crescent, Portsmouth, gentleman; and J. F. Hooper, 32, Great Southsea Street, Southsea, fish merchant. No initial public issue. The number of directors is not to be less than five nor more than 10; the first are J. M. Brown, R. H. Brown, jnr., W. S. Brewer, H. F. Byerley, H. C. Cooke, P. Gaskell, P. H. Goodman, and J. F. Hooper; qualification, £25; remuneration as fixed by company. Registered office, 3, King's Terrace, Southsea.

SUPPLY STATION ACCOUNTS.

Belfast Corporation Electricity Accounts.

The accounts for last year have now been issued by the Corporation of Belfast, and they show that the electricity supply undertaking is doing an increased business; the growth in the output is exceedingly favourable, as the increase in 1900 exceeded that of the preceding year by nearly 20,000 units. The old order of things has given place to the new, and the steam-driven station is showing the expected economies.

General Statement.

	1899.	1900.	Inc.
Total capital expenditure ...	£150,607	£173,889	£23,282
Number of units sold	622,486	908,067	285,581
No. of 30-watt lamps connected...	51,500	84,629*	33,129
Maximum load in KW.	955	1,307	352
Gross revenue	£11,679	£14,898	£3,219
Gross expenditure...	£5,743	£7,133	£1,390
Gross profit	£5,936	£7,765	£1,829
Average price per unit sold ...	4·36d.	3·76d.	−·60d.

* To August, 1901.

The average price received for energy has now fallen to nearly 3¾d., by the operation of the demand system; the rates being 6d. and 2d. for lighting, and 3d. and 1d. for power, with a flat rate of 5d. for places of worship. The proportion of sales at the varying rates was:—

	Units generated.	Public lamps.	Private sales. At 7d.	At 6d.	At 5d.	At 4½d.	At 2d.	Motors. At 4d.	At 3d.
1898	414,007	—	256,998	—	3,986	—	50,631	26,045	—
1899	742,590	6,192	278,515	—	8,087	—	255,631	25,500	—
1900	1,091,895	10,211	—	382,644	16,635	77	352,556	4,000	53,769

	Motors. At 2¾d.	At 1¾d.	At 1½d	At 1¼d.
1898	—	—	14,089	4,760	—	—
1889	—	—	20,289	—	28,152	—
1900	—	—	22,218	—	—	65,627

The public lamps are still insignificant, being represented by 56 10-C.P.

Revenue Statement.

	1899. Gross.	Per unit.	1900. Gross.	Per unit.	Inc.
Sale of energy	£11,308	4·36d.	£14,226	3·76d.	−·60d.
Meter rents	316	·12d.	642	·17d.	+·05d.
Sale of lamps, &c.	51	·02d.	—	—	−·02d
Sundry fees and premiums ..	4	·00d.	30	·01d.	+·01d.
Gross revenue ...	£11,679	4·50d.	£14,898	3·94d.	−·56d.

Mr. Victor A. H. M'Cowen, the city electrical engineer, must be congratulated upon the reduction of total costs below 2d. per unit. The fuel bill was nearly all coal in 1899, and included coal only last year. The usual upward tendency is show in this item by the increase of almost $\frac{1}{10}$d., but as wages have been reduced from a gross figure of £1,477 to £1,342, thus saving nearly ¼d. per unit, and all the other items show some reduction, the change in coal is swamped by other economies, leaving the works costs better by almost ½d. at 1⅓d., and total cost just under $1\frac{9}{10}$d.

The following figures show the proportion of losses for the system:—

	1896. Per cent.	1897. Per cent.	1898. Per cent.	1899. Per cent.	1900. Per cent.
Total efficiency ...	93·8	89·2	89·4	88·4	87·9
Loss in batteries ...	3·9	5·4	5·3	6·2	3·9
Loss in mains ...	2·3	5·4	5·3	5·4	8·2

Cost of Production.

	1899. Gross.	Per unit.	1900. Gross.	Per unit.	Inc.
Coal (and other fuel)	1,754	·67d.	£2,856	·75d.	+·08d.
Oil, waste, water and engine room stores	247	·10d.	267	·07d.	−·03d.
Salaries and wages incurred in generation and distribution, and attending street lamps	1,477	·57d.	1,342	·35d.	−·22d.
Repairs and maintenance of buildings, engines, boilers, dynamos and renewals of street lamps	457	·18d.	629	·17d.	−·01d.
Works cost ...	£3,935	1·52d.	£5,094	1·34d.	−·18d.
Rent, rates and taxes ..	724	·28d.	728	·19d.	−·09d.
Management expenses, salaries of managing engineer, secretary, clerks, &c., and meter inspection	534	·20d.	676	·18d.	−·02d.
General establishment charges, stationery and printing, law charges and insurance	539	·21d.	635	·17d.	−·04d.
Other expenses	11	·00d.	—	—	—
Total costs ...	£5,743	2·21d.	£7,133	1·88d.	−·33d.

The net profit appears small compared with 1899, but this is attributable to the large increase in financial charges, which have nearly doubled, and now absorb £7,289 as against £3,813. This increase of £3,476 was not covered by improved gross profits of £1,829, the result being a diminution in net profits of £1,647, leaving £476 to be carried forward—a sum not very different from that obtained in 1898.

Profit Statement.

	1899.	1900.
Interest and dividends on loans and stock	£2,837	£5,066
Sinking fund for repayments and redemption of stock.	976	2,223
Net profit carried forward	2,123	476
Gr profit	£5,936	£7,765

Parliament of Labour.

should be elastic, to permit of free development,

CITY NOTES.

Blackpool and Fleetwood Tramways Company.

THE half-yearly meeting of the shareholders of this company was held on 22nd inst. at Manchester. Mr. George Richardson, chairman of the company, presided.

From the report of the directors it appeared that the number of passengers had been 648,569 and the receipts £10,183. The balance of profit after providing for debenture interest was £3,556, and the directors recommended a dividend of 4 per cent., which would absorb £3,000; £500 was written off for the depreciation reserve, leaving a balance of £56 to carry forward. The CHAIRMAN, in moving the adoption of the report, said that considering that they had not taken anything from the reserve and were yet able to pay the same dividend as last year the report was a satisfactory one. There had been a slight increase in wages, but every possible economy was exercised. The gross receipts, in spite of the bad weather in the early part of the year, were £126 in excess of those of the previous period. The new Fleetwood estate was being laid out, and soon, he hoped, there would be a continuous line of houses from Fleetwood to Blackpool.

The report was adopted.

Hong Kong Electric Company, Limited.

THE twelfth ordinary general meeting of the shareholders in the above company was held at the office of the general managers, Messrs. Gibb, Livingstone & Co., on July 13th.

Mr. C. S. SHARP (chairman of the company) presided, and said that the report showed continued progress. The receipts from current supplied showed a satisfactory advance, whilst the profit on working is some $11,000 better.

There were no questions, and on the motion of the CHAIRMAN, seconded by Mr. G. T. VEITCH, the report and statement of accounts were accepted and passed.

The Hon. J. Thurburn and Mr. C. S. Sharp were re-elected directors, and Messrs. J. C. Peter and Murray Stewart were re-elected auditors.

TRAFFIC RECEIPTS.

Blackpool and Fleetwood Tramways.—The receipts for the week ending August 24th were £2,421; corresponding week last year, £1,845; increase, £576. Total to date, £11,824; corresponding period last year, £11,606; increase, £218.

Bristol Tramways and Carriage Company.—The receipts for the week ending August 23rd were £4,123; corresponding period last year, £3,454; increase, £669.

Central London Railway.—The receipts for the week ending August 24th were £5,409; corresponding week last year, £4,385; increase, £1,024. Total receipts from July 1st (8 weeks), £45,615. Miles open, 6.

City and South London Railway.—The receipts for the week ending August 25th were £1,697; corresponding week last year, £1,473; increase, £224. Total to date, £14,608; corresponding period last year, £12,008; increase, £2,600. Miles open, 4¾.

Dover Corporation Tramways.—The receipts for the week ending August 24th were £335 1s. 6½d.; corresponding week last year, £324 6s. 0d.; increase, £10 15s. 6½d. Total to date, £7,270 13s. 9½d.; corresponding period last year, £6,834 11s. 3d.; increase, £436 2s. 6½d. Miles of track open, 3. Car miles run, 1901, 5,225; 1900, 5,204. Number of cars, 1901, 12; 1900, 11.

Dublin United Tramways Company.—The receipts for the week ending August 23rd were as follows:—D.U.T. Co., electric cars, £4,149 1s. 3d.; D.S.D. Co., electric cars, £1,187 0s. 1d.; total, £5,336 1s. 4d.; corresponding period last year—D.U.T. Co., electric cars, £3,729 9s. 0d.; ditto, horse cars, £29 11s. 7d.; D.S.D. Co., electric cars, £1,048 11s. 3d.; total, £4,807 11s. 10d.; increase, £528 9s. 6d.; aggregate to date, £41,065 3s. 5d.; aggregate to date last year, £39,316 18s. 2d.; increase, £1,748 5s. 3d. The mileage worked is 45 miles electrically, as against 42 miles electrically, and two miles by horses, for the corresponding period last year.

Liverpool Overhead Railway.—The receipts for the week ending August 25th were £1,778; corresponding week last year, £1,767; increase, £11. Total from July 1st to date, £14,084; corresponding period last year, £13,960; increase £124. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

THE remarkable ease now prevailing in the Money Market finds full reflection throughout our price lists this week. For a million pounds' worth of Treasury Bills, the Government received applications amounting to more than seven times as much, and the paper was allotted at an average of £2 19s. per cent. This, of itself, suffices to show the plenitude of money, and, besides this, the financial world bristles with "tips" to buy—not speculative mining shares—but stocks of the gilt-edged order. What restrains a boom in this variety is simply the flatness of Consols. The Funds appear wholly unable to cope with the especial circumstances that are pinning the price down, but, although this weakness ties the advance to some extent of other first-class investments, the latter are slowly throwing off their allegiance to the hitherto acknowledged leader of gilt-edged securities, and both Debentures and Preference are in good demand. There are more than half-a-dozen such rises this week in the Telegraph Market alone.

Discussing the Electrical Supply list with a dealer in the shares, we were told of the same conditions ruling here as in other investment parts of the Stock Exchange. Blocks of Debenture stocks that have been floating about for some time are getting placed, he assured us, in the hands of the genuine investor, while it is becoming increasingly difficult to obtain cheap stock of this description. And it will be observed that Metropolitan Debenture stocks are both better, the 3½ per cent. substantially so, having a 3 point rise to its credit. Charing Cross and Strand 4 per cent. Debenture is harder at 104, and there is a general tightening of the supply of stock throughout this market. In this connection we may perhaps suggest the attractiveness of City of London 4½ per cent. Second Debenture stock, now standing at 1 per cent. over par. Seeing how much better the company is now doing, the stock is certainly worth placing in a list of good second-grade investments. Dividends are payable at the end of June and of December.

Among the Ordinary shares, Metropolitans are inclined to be weak, although the nominal quotation remains unchanged. Diligent inquiry fails to discover any valid reason for the dullness, which must therefore, we suppose, be ascribed to the negotiations between the company and the Marylebone Vestry. South London Electrics remain in the neighbourhood of 50s., but for the best Electric Supply Ordinary shares, there is a very good tone, except as regards Metropolitans, Brompton and Kensington being the only shares to show the improvement visibly.

The Manufacturing brigade is also firming up. Henley's are better, the 10 per cent. interim dividend bringing in a few tardy purchasers, and of course Callender's could not allow Henley's to advance by themselves. Both companies are said to be doing very well at the present time. British Westinghouse Preference are at last receiving some little attention, and are ¼ better at £5 middle, their par value. As we mentioned a couple of weeks ago, they are 6 per cent. shares, and are non-cumulative. The shares are also entitled to one-fourth of the profits remaining after payment of 6 per cent. on the Ordinary capital.

Disclaiming any desire to appear pessimistic, we expected in our last notes that British Insulated Wire would see a decline in price, so that a fall of 30s. per share in them during the week will not have surprised our readers. The market is very narrow. A fall of 15s. has also occurred in the Preference. Those who followed the unhappy case of the British Electric Works Company will have no trouble in surmising the probable cause of the fall in British Insulated Wire shares.

Excellent buying of Central London stocks has lifted the Ordinary a full 4 points this week, and the Preferred marks a gain of 2, standing now at 106½. Those who picked up the latter stock a few weeks ago at 10 per cent. cheaper need be in no hurry to sell, although we should be sorry to restrain the taking of profits by those who heed our suggestions, if they wish to secure them. Waterloo and City stock remains stationary, the demand for it in a limited market having stopped. Great Northern and City "A" Perferred are 8, Metropolitan Consolidated is 81, and at 30 District stock is the same as it was a week ago.

In the telegraph market, the feature is the buying of Debenture and Preference stocks, as already mentioned. The Eastern group has been favoured in this respect, but the Ordinary issues present no alteration. Anglo-American stocks are moving with their usual perversity, the Deferred being ¼ up, whilst the Ordinary is a point lower. Western Telegraph shares are improving in price, the good report beginning to make itself felt after many days. West India and Panama shares have slipped back to 7s. 6d., and Cuba Telegraph Preference are 10s. down on a solitary selling order coming to the market. Amazon Telegraph Debentures have ceased their giddy fluctuations, and even the shares are settling down to £4. The only moves in the telephone market are a brace of rises in National First and Second Preference, each of which has gained a sovereign. Evidently some one else besides ourselves has been thinking that they look attractive, despite the narrowness of the market.

Traction varieties are steady, with very little change. British Electric Preference are wanted, but for the Ordinary there is not much inquiry. British Columbia Electric Railway shares are much weaker than they appear to be from the official quotations. The Preference, which are called 9¼ to 9¾ in the official organ of the Stock Exchange, are much nearer 9 than 9½, and the Ordinary, instead of being quoted 6 to 6½, should be at least 5s. cheaper. Dublin trams are almost a dead market, the Ordinary and Preference being 12½ and 15 respectively. Both the "A" and "B" Preference shares of the Buenos Ayres and Belgrano electric trams are quoted at 5½, the middle price.

expected economies.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Aug. 21st.	Closing Quotations Aug. 28th.	Business done during week ended Aug. 28th, 1901. Highest.	Lowest
96,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —102	99 —102	...	...
119,700*l*	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red.	100	...	...	...	78 — 83	78 — 83	...	...
822,700*l*	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	52 — 55 xd	51 — 54	54	...
3,088,540*l*	Do. do. 6 % Pref	Stock	6 %	6 %	6 %	97 — 99 xd	97 — 99 xd	98½	97½
3,088,540*l*	Do. do. Deferred	Stock	18s. %	£1 7s.	5s.%	9⅜— 10½	10 — 10½	10	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	5 %	3⅜— 4½	3⅜— 4½	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	175 —185	175 —185 xd	...	...
1,589,496*l*	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	101 —103	101 —103	103	101⅜
16,000	Cuba Telegraph	10	8 %	7 %	...	5 — 6	5 — 6	...	...
6,000	Do. 10 % Pref.	10	10 %	...	...	14½— 15½	14 — 15	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3 — 4	3 — 4	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10	...	...
30,000*l*	Do. do. 4½ % Debs.	50	...	...	...	99 —103¾ xd	100 —104	...	...
60,710*l*	Direct United States Cable	20	3½%	3½%	3½%	10½— 11½	10½— 11½	...	...
104,300*l*	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102 xd	100 —103	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	143 —148	143 —148	145½	143
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	95 — 98	96 — 99	98	...
1,432,268*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	113 —116	114 —117	115	114½
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	13⅜— 14¼	13⅜— 14¼	14	...
320,000*l*	Do. 4 % Deb. Stock	Stock	...	...	...	113 —118	114 —119	...	...
300,000*l*	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	5¼ %	...	99 —102	100 —103	101¼	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	101 —104	101 —104	...	...
180,227	Globe Telegraph and Trust	10	5⅛%	5⅛%	5⅛%	10½— 10⅝xd	10½— 11	10⅝	10½
180,042	Do. do. 6 % Pref.	10	6 %	...	...	14⅜— 15½xd	14⅜— 15½xd	...	...
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	15 %	31 — 33	31 — 33	...	...
78,000*l*	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	41 — 45	41 — 45	44	...
100,000*l*	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	104 —107	105 — 108	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680	1	...	2½%	...	¼— ⅜	¼— ⅜	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	⅝— 1	⅝— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3⅞— 4⅛	3⅞— 4⅛	4 1/16	3⅞
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13	12 — 14	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	12 — 14	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4⅝— 5	4⅝— 5	4 1/16	...
2,000,000*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	92 — 95	92 — 95	92	...
500,000*l*	Do. 4 % Deb. Stock Red.	100	...	...	4 %	95 — 98	95 — 98	97	96
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	6 %	⅞— 1	⅞— 1	...	...
100,000*l*	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	...	...	...	100 —103	100 —103	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	126 —131	126 —131	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	5 — 5½xd	5 — 5½	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4⅜— 5½ xd	4⅜— 5½xd	...	...
179,947*l*	Do. do. 5 % Debs.	Stock	...	...	...	102 —105	102 —105	...	...
171,000	West African Telegraph, 5 % Debs.	100	...	...	...	101 —104	101 —104	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	...	...
150,000*l*	Do. do. 4 % Debs., 1—1,500 gua. by Bras. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	13⅜—14¼ xd	14 — 14½	14½	14⅛
75,000*l*	Do do. 5 % Debs. 2nd series, 1906	100	...	...	...	101 —104 xd	102 —105	103½	...
348,777*l*	Do. do. 4 % Deb. Stock Red.	100	...	...	...	101 —104	102 —105	...	...
88,321	West India and Panama Telegraph	10	2 %	⅝%	...	¼— ⅜	¼— ½	...	...
34,583	Do. do. do. 6 % Cum. 1st Pref.	10	...	...	...	5 — 6	5 — 6	5⅜	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	...	...	...	3 — 5	3 — 5	...	...
80,000*l*	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	101 —104 xd	101 —104 xd	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7½— 8 xd	7⅞— 8¼	...	...
12,000	Do. do. 7 % Cum. Pref.	5	...	...	...	8¼— 8⅜xd	8½— 9	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9 — 10 xd	9 — 10	9⅛	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5¼— 5⅜xd	5¼— 5⅜	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	5½— 6	5½— 6	...	...
150,000*l*	Do. do. do. % Deb. Stock Red.	Stock	...	...	...	107 —110	107 —110 xd	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579	10	6 %	4 %	0 %	8 — 9	8 — 9	8⅜	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	11½— 12½	12 — 13 xd	12 1/16	11⅞
400,000*l*	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	120 —125 xd	120 —125 xd	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	nil	4 %	4 %	8 — 9 xd	8½— 9½	...	...
20,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	12 — 13 xd	12 — 13	...	..
200,000*l*	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd.	...	...	...	...	103 —106 xd	103 —106 xd	...	..
35,500	Edmundson's Elec. Corp., Ord. Shares	5	6 %	6 %	7 %	5⅜— 6¼	5½— 6 xd	5 1/16	...
20,000	Do. do. 6 % Cum. Pref.	...	...	...	...	5½— 6	5½— 6 xd	5⅝	5 1/16
120,000*l*	Do. do. 4½ % 1st Mort. Deb. Stock.	100	...	...	...	104 —107	102 —105 xd	105¾	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	...	...	...	11 — 12	11 — 12 xd	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	101 —104	101 —104 xd	...	...
110,000	London Electric Supply Corporation, Limited, Ord.	3	...	...	...	1½— 1⅝	1½— 1⅝	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	4 — 5	4 — 5	...	...
250,000*l*	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	96 —100	96 —100	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	13 — 14 xd	13 — 14	13½	...
220,000*l*	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	109 —112	108 —111 xd	...	...
250,000*l*	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	94 — 97 xd	94 — 97 xd	...	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15 — 16	15 — 16 xd	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½— 15½xd	14½— 15½xd	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½xd	...	...
150,000*l*	Do. do. 3½ % Deb. Stock Red.	100	...	...	...	97 —100 xd	97 —100 xd	98	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2⅜	...	...
50,000*l*	Do. do. 4 % Deb.	100	...	...	...	80 — 90 xd	80 — 90 xd	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2 — 3	2½— 3⅜	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000	5	12 %	13 %	10½%	12 — 13 xd	11½— 12½	12 1/16	...

* Subject to Founders Shares. Quotations on Liverpool Stock Exchange.
Unless otherwise stated all shares are fully paid. ‡ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation Aug. 21st.	Closing Quotation Aug. 28th.	Business done week ended Aug. 28th, 1901. Highest	Lowest.
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	7 — 8	7 — 8	...	...
300,000*l*	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	89 — 93	89 — 93	...	...
45,000	British Electric Traction	10	6 %	8 %	9 %	13⅜— 14¼	13⅜— 14¼	14¼	14
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	11¾ — 12¼xd	11¾ — 12¼	...	...
350,000*l*	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	122 —125	122 —125	124½	...
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	9½ — 10½	8 — 9	9⅛	9
70,000	Do. do. 6 % Cum. Pref.	5				6 — 6½xd	5¼ — 5⅜	6	...
50,000	¶Browett, Lindley & Co. (1899), Ord.	£1	...	...	8 %	...	7/8 — 1	...	...
50,000	¶ " " " 6 % Cum. Pref.	£1	...	...	6 %	...	1 5/16 — 1 1/16	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	5 %	6 %	...	1½ — 1¾	1½ — 1¾	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2 — 2¼	2 — 2¼	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	103 —108	103 —108	106½	...
108,710*l*	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	99 —102	99 —102 xd	...	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	15 %	14½—15½	15 — 16	...	...
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5⅜ — 6¼	5⅜ — 6¼	...	...
90,000*l*	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	108 —112	108 —112	...	...
1,969,800	Central London Railway, Ord. Stock	Stock	...	...	...	99 —102	103 —106	105	102
440,100	Do. do. 4 % Pref. Stock	Stock	...	...	...	103 —106	105 —108	107½	102
440,100	Do. do. Def. do.	Stock	...	...	...	98 —101	98 —101	101	100
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1¼%	52 — 54 xd	52 — 54 xd	...	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	5½ — 5⅝	5½ — 5⅝	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	8 %	3¼ — 3⅜xd	3¼ — 3⅜	...	...
100,000*l*	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	100 —105	100 —105 xd	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	2½%	0 — ¼	0 — ¼	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	2½%	1½ — 2⅛	1½ — 2⅛	...	...
344,023*l*	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	80 — 85	80 — 85 xd	...	...
100,000*l*	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	85 — 90	85 — 90	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1½ — 2	1½ — 2	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2⅛ — 2⅜	2⅛ — 3⅛	...	...
152,500*l*	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	98 — 02 xd	98 —102 xd	...	...
18,000	General Elec. Co. (1900) 5 % Cum. Pref.	10	...	...	...	9⅜— 10⅛	9⅜— 10⅛	...	...
150,000	Do. do. 4 % Mort. Deb.	Stock	...	...	...	99 — 102	99 —102	...	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	16 — 17	16½ — 17½	16⅝	16½
35,000	Do. do. do. 4½ % Pref.	5	...	4½%	4½%	5½ — 6	5½ — 6	...	...
50,000*l*	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	110 —114	110 —114	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	21	...
300,000*l*	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3⅝%	3½%	7½ — 7⅝	7 3/8 — 7 5/16	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	13½ — 13⅝	12⅝ — 13	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	...	6 %	19/- to 20/-	... ...	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	38 — 42	38 — 42	41	39
150,000*l*	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	104 —106	104 —106	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	12 %	10½ — 11½	10½ — 11½	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5⅜ — 6¼	5⅜ — 6¼	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	92 — 95	92 — 95	94	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, 1/16—3/16
National Electric Free Wiring, 12/6 paid, ⅛—⅛.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 15½—16½.
Do. do. Pref. (£10 pd.), 10—11.
*T. Parker, £10 (fully paid), 16½.

* From Birmingham Share List.
¶ From Manchester Share List.

Bank rate of discount 3½ per cent. (June 6th, 1901).

MARKET QUOTATIONS, Wednesday, August 28th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a " Nitric	per cwt.	22/-	22/-	..
a " Oxalic	per cwt.	32/-	32/-	..
a " Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	89/-	89/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	£33 10	..
a " " ..	per ton	£90	£90	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£15	£15	..
a Benzole (90 %)	per gal.	7/-	7/-	..
a " (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£22	£23	£1 dec.
a Lead, Nitrate	per ton	£24	£24	..
a " White Sugar	per ton	£31	£31	..
a " Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	5¼d.	5¼d.	..
a " Caustic (75/80%) ..	per ton	£24	£24	..
a " Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	80/-	81/-	19/- inc.
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a " Recovered	per ton	£5 10	£5 10	..
a " Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a " Crystals	per ton	£8	£8	..
Bichromate, casks ..	per lb.	2¾d.	2¾d.	..

METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b " Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£75 to £140	£75 to £140	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c Tube (brazed)	per lb.	10d.	10d.	..
c " " (solid drawn) ..	per lb.	8½d.	8½d.	..
c " Wire, basis	per lb.	8d.	8d.	..
c Copper Tubes (brazed) ..	per lb.	11d.	11d.	..
" " (solid drawn) ..	per lb.	10½d.	10½d.	..
g Copper Bars (best selected) ..	per ton	£82 to £83	£82	inc.

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£82 to £83	£85	dec
g " Rod	per ton	£82 to £83	£85	dec.
e " (Electrolytic) Bars ..	per ton	£82	£82	..
e " " Sheets ..	per ton	£90	£90	..
e " " Rod	per ton	£84	£84	..
e " " H.C. Wire	per lb.	9¾d.	9¾d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f " Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/5	1/5	..
h Gutta-percha fine	per lb.	8/-	8/-	..
h India-rubber, Para fine	per lb.	3/8 to 3/9	3/9 to 3/10	1d. dec.
t Iron, Charcoal Sheets	per ton	£18	£18	..
t " Pig (Cleveland warrants) ..	per ton	45/4	46/3	11d. dec.
t " Forgings, according to size	per ton	From £11	From £11	..
t " Scrap, heavy	per ton	50/- to 52/6	50/- to 52/6	..
t " Wire, galvanised No. 8 ..	per ton	£10	£10	..
g Lead, English Ingot	per ton	£12 to £12 2 6	£12	inc.
g " " Sheet	per ton	£13 5	£13 5	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9	£9	..
d Mica (in original cases), small ..	per lb.	8d. to 9d.	8d. to 9d.	..
d " " " medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d " " " large ..	per lb.	3/8 to 7/8	3/8 to 7/8	..
p Phosphor Bronze, plain castings	per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p " rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p " " strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£4 1	£4 1	..
p Silicium Bronze Wire ..	per lb.	10½d. to 1/0¼	10½d. to 1/0½	..
t Steel, Magnet, acc'd'ng to deso'p'n	per ton	From £15	to £40	..
t " " in bars		£58	£58	..
g Tin, block	per ton	£119	£118 10 to £119 10	..
g " foil	per lb.	1/6	1/6	..
n " wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£35 to £65	£35 to £65	..
j Yarns, Cotton, Single 10 lb. b'ndl's	per lb.	..	8½d.	..
j " Best Flax, 6 lea.	per lb.	..	6d.	..
j " Hemp, 3 ply 10 lbs. ..	per lb.	..	4⅞d.	..
j " " Russian, 10 lbs. ..	per lb.	..	5⅜d.	..
j " Jute, 180 lbs. rove ..	per ton	..	£14	..
k Zinc, Sh't. (Vielle Montagne bnd.)	per ton	£22 10	£22 10	..

Quotations supplied by { a Messrs. G. Boor & Co. b The British Aluminium Co., Ltd. c Messrs. Thos. Bolton & Sons. d Messrs. F. Wiggins & Sons. e Messrs. Frederick Smith & Co. }

Quotations supplied by { f India-Rubber, G.-P. and Teleg. Works g Messrs. James & Shakspeare. [Co., Ltd. h Messrs. Jackson & Till. t Messrs. Bolling & Lowe, }

Quotations supplied by { k Messrs. Morris Ashby, Limited m Messrs. W. T. Glover & Co., Ltd. n Messrs. P. Ormiston & Sons. o Messrs. Johnson, Matthey & Co., Ltd. p The Phosphor Bronze Company, Ltd. }

THE INTERNATIONAL ENGINEERING CONGRESS OF 1901.

The opening ceremony of what will probably be the most important and epoch-making engineering conference ever held in the United Kingdom, perhaps in the world, will take place on Tuesday next. In this memorable gathering 27 societies and institutions will collectively take part, and in the nine sections into which the Congress is divided there will be found much of the highest interest to the electrical engineer; no less than seven of them have down for reading papers directly connected with the electro-technical industry, the papers themselves numbering between 20 and 30. The Congress will continue till the 6th proximo, and the programme includes meetings for the reading of papers, visits to works, excursions and entertainments.

The Second City of the Empire, already the scene of several notable gatherings since the opening of its famous Exhibition, is the rendezvous of the great International Engineering Congress of 1901, and Glasgow may well be proud of the part it has so far played in the first year of the new century, and of what it has yet to perform before the year expires, for the B.A. meeting is to be held there the week following the Engineering Congress.

The grounds of the Exhibition will be open during the week to the members of the Congress, a special gate being devoted to their use, and during the week the Automobile Club will hold a 500 miles' trial of motor vehicles, a matter to which we alluded very fully in our issue of August 9th.

The office bearers include Lord Kelvin as hon. president, and Mr. James Mansergh (president of the Institution of Civil Engineers) as president of the Congress, while the eleven vice-presidents are all presidents or past-presidents of one or other of the Institutions represented at the Congress.

The London Committee consists of over 100 well-known engineers and representative men of science, with Sir Douglas Fox as chairman, and Dr. Tudsbery, that worthy successor of Mr. James Forrest, as secretary.

The Executive Committee includes many members of the London Committee, and numbers over 50 gentlemen of world-wide eminence in their respective walks in life.

There are nine sub-committees for visits to works, and one each for excursions, rooms and billeting.

The list of large and representative works, huge ship-building yards, &c., open to Congress members number just upon 80, and altogether it seems that the first week in September will be a memorable one in the engineering history of Great Britain, and for that model municipality the city of Glasgow, and one that augurs well for her greater prosperity and importance in the industrial world.

The organisation of the Congress must have involved almost Herculean labour; so far as one can judge previous to the commencement of the week's work, it has been admirably carried out, and to Mr. J. D. Cormack, the general secretary, and to the secretaries of the Sections, the hearty thanks of everybody attending the Conference will doubtless be extended.

It is quite impossible in the limited space at our command to bring before our readers all the subjects, most of them of considerable concern to the electrical world, which are to be threshed out during the three days devoted to the serious business of the meeting, but it may not be out of place to offer a brief commentary on some which we deem of immediate moment.

Starting without any attempt at the order in which they appear, we notice one by Mr. H. A. Mavor, on "Continuous Current Dynamo Design."

It would seem that the most important point which is still in doubt in the design of continuous current machines is the question of sparkless commutation. We have heard of numerous instances of machines constructed by leading firms which do not give satisfaction at the commutators, and after having carefully gone through all the latest works on the subject (including Parshall & Hobart's book), it is a question whether there is a single text book in print which would enable a designer to design a sparkless machine with certainty.

We know of one engineer who gave a great deal of attention to this, and who went into it from a point of view which nobody else seems to have thought of. He has not yet sufficiently verified it to say anything about it publicly, but the machines designed on his lines were invariably sparkless. He recently designed a special motor for some firm. He was not present at the tests, but their managing director in a letter to him said: "There is much in the general behaviour of the motor which I like; for instance, the absence of sparking is very striking."

Another paper, by Prof. A. Jamieson, is on the very debatable subject of "Dangers from Trolley Wires and their Protection." It seems that the dangers from trolley wires are of two kinds; those arising from the falling of telephone or telegraph wires; and secondly, those from falling trolley wires themselves. The first is certainly the easier to overcome, but undoubtedly the best method is to place these wires underground. The difficulty which exists in this direction is that local authorities or companies have no jurisdiction over the wires which belong respectively to the Post Office, Telephone Company, and private people. If we recognise that overhead wires must exist, then probably the best protection is the earthed guard wire, but to complete the earthing of guard wires, the posts supporting these guard wires or poles, or some of them in the section of guard wire, should be bonded to the rails.

The falling of a single telegraph or telephone wire under these circumstances does not give rise to danger, since the telephone wire will fuse asunder the moment it makes contact with the trolley wire and earthed guard wire; but for the falling of a bunch of telegraph or telephone wires further protection is necessary. In this case the usual result is the welding of the telegraph or telephone wires to the guard wire or trolley wire. If the guard wires are well earthed, sufficient current will pass to operate an automatic device, either electro-magnetic or otherwise; but it would seem that whatever maximum current device be used, it should be within sight of the section protected. What is the usual programme when a cut-out comes out in a tramway generating station? Simply to replace the cut-out. If it comes out it is again put in, this being repeated three or four times. If it still insists upon coming out, it is given a rest for a moment, and then switched in again. During one of these intervals, while sparking ceases on the section damaged, some poor unfortunate endeavours to remove the fallen wires, and just as he has got nicely hold of them, in goes the cut-out. Now, practically, all short circuits taking place on a tramway system are external to the section box, therefore it might be preferable to put fusible cut-outs to the feeders on the switchboard, and maximum current devices at the section box.

As regards falling trolley wires, there are many devices now on the market. Many of them appear to have elements of success in their design, but the principal point to be borne in mind in regard to them is this:—That the trolley wire shall not be able to fall in contact with passengers on the upper deck while it is alive.

Many of the devices now on the market will not succeed in this respect. With regard to the well-known plan of Mr. Robt. C. Quin, much has been said of the need for the actual division of the sections of the trolley wire. This is by no means a necessity, though we believe he prefers the insulation of the sections. At the same time he is quite prepared to put up this automatic device on any system of overhead trolley line, and to put it to the same test as he has done with insulated sections.

Mr. Sidney F. Walker, who, as everybody knows, has devoted much attention to the introduction of electricity into mining operations, will deal with "Alternating Currents and their possible Application to Mining."

The subject of electric light and power in mines presents most difficulty, we think, in the wiring. It is more than likely that in a question of continuous *v.* polyphase, motors built on the latter plan have the advantage, but they require three wires as against two. Wiring down to the pit bottom for haulage and main pumps present no difficulties, but when we penetrate into the mine up to the working faces, the case is very different; in these places the machinery must be movable, and long lengths of wire are exposed to many dangers. How to safely and satisfactorily deliver the electric energy at the constantly shifting workings is a real problem.

Touching the question of "The Economy of Electricity as a Motive Power on Railways at present Driven by

[c Messrs. Frederick Smith & Co.
[p The Phosphor Bronze Company, Ltd.

Steam," by Prof. C. A. Carus-Wilson, we would ask is there much economy in electricity, unless the fuel can be cheaply obtained? The fuel cost of electricity is vastly greater than that of steam locomotives unless there is a large load factor, and large load factors may mean frequent stoppages from "shorts," owing to the great area of the electrical system necessary to produce a large load factor.

Enthusiasts like Mr. Langdon, the estimable president of our Institution, may talk about power for 3 lbs. of coal per unit, but do they really speak in full possession of the facts?

At all events, facts in electrical tramway practice point to the expenditure of 6 to 14 lbs. of coal per unit; 6 lbs. for a load factor of about 45 per cent., and 14 to 16 lbs. for load factors of 16 to 20 per cent.

The coal consumption is practically inversely as the load factor, hence the importance of a large area in connection, or of the employment of accumulators.

The articles by Mr. Booth in our issues of January 18th and 25th, 1901, might be perused with advantage by those who intend to join in this discussion.

The steam turbine has come to stay, and doubtless the Hon. C. A. Parsons and Mr. G. Gerald Stoney will invest this wonderful prime mover with still greater importance in their joint paper on "Trials of Steam Turbines for Driving Dynamos." Mr. Parsons must, however, look to his laurels, for did not leading organs of the daily press last week inform us in their own inimitable way that a new turbine engine has been constructed to the designs of Mr. Graydon, the projector of the big wheel at Earl's Court? He claims many advantages over the Parsons type, especially in the economical use of steam and the saving of fuel.

It is intended to use the turbines for all purposes, including motor and dynamo driving, and on board ship. In the latter case, says the representative of the *Standard*, very high speed, even for big vessels, is promised, especially when the fuel used is petroleum.

Would it be credited that in that self-same issue of the *Standard* is another article yclept "Oil Fuel in Steamships," in which it is shown on the authority of *Engineering* that in naval practice oil does not give the same amount of steam from water-tube boilers as is commonly obtained from coal. In fact, the maximum power obtained with oil in the Admiralty experiments in the *Surly* with small tube boilers is less than half that obtainable with coal, and in any case there are special risks attending its use on board warships.

From the jumbled descriptions of Mr. Graydon's turbine we expect Mr. Parsons need be under no apprehension that his well-known steam eater, as it was formerly dubbed, might as well be scrapped.

Possibly the discussion on the paper may take the form of drawing particular attention to the non-reversibility of the steam turbine and the great drawback to the use of the apparatus as a method of propelling boats which is occasioned thereby. Another important feature, which, however, is known to all steam engineers, is the fact that owing to there being no means of suitably governing the speed under variations of load on the propeller, the engine invariably races when the boat is in a rough sea and when the propeller is lifted clear of the water.

This seems to be an important subject for discussion in connection with all methods of marine propulsion, and it is significant that while the governing of fixed steam engines of all kinds has been reduced to a science, the governing of a steam turbine still remains practically where it was years ago.

We cannot lay claim to acquaintance with the "High Speed Railway Car of the Allgemeine Elektricitäts Gesellschaft, of Berlin," on which Mr. O. Lasche is to dilate, but we would suggest if it leads to the introduction of the Behr railway into the controversy, that intimate knowledge is principally lacking in respect of the size and bulk of motors, braking effects, and of the resistance of trains and vehicles generally. We would like to touch on the danger of *clip* brakes on the longitudinal members of the Behr structure. A high speed train with a powerful *clip* brake would put a heavy stress on a bar, and might rip it out of the structure. Generally, we see no special safety in the Behr system. High speed can be most safely secured by straightness. Given a straight line, a fast-running train cannot leave it, because of the centrifugal effect, but little attention, however, seems to have been paid to the danger of the enormous cross breaking stress (due to the centrifugal tendency of the outer half of the Behr car round curves) brought upon the top.

Mr. B. H. Thwaite again returns to his favourite theme, "The Profitable Utilisation of Power from Blast-Furnace Gases."

Readers of the Electrical Review are familiar with the author's work in this direction, and they will, we feel sure, wish Mr. Thwaite a successful issue out of his labours to make power-users appreciate more fully the advantages of these gases. Roughly, we burn about 10 million tons of fuel, or perhaps 15 million tons of coal, every year in the blast-furnaces of Great Britain. Tests made by Mr. Booth at Wishaw, near Glasgow, showed 1 E.H.P.-hour per each 1½ lbs. of coal put into the blast-furnace, *i.e.*, a blast-furnace and a gas engine are equal to high-class triple-expansion engines, and the iron is given in as a bye-product.

The present waste of these gases is little less than sinful; all the tramways in the country might be worked by their utilisation, but men of capital seem not to understand, or if they understand, do not appear to realise what an enormous field there is for their development, even if used for charging storage batteries, as furnaces run all night.

Superheated steam has also from time to time received much attention in our columns, and Mr. R. Lenke's paper entitled "Some Experiences and Results Derived from the Use of Superheated Steam in Engines," should be prolific in valuable information. The main benefit of superheated steam is that heat is conveyed to the right spot; the cylinder inside surface and piston face. It prevents condensation, there is then less re-evaporation, again less condensation, and so on, for there can be no cylinder cooling if there is no water to evaporate. Probably the chief benefit of superheat is obtained out of the first 100° F. Steam, if too hot, has its difficulties, and is undesirable in many ways; superheat is cumulative in its effect, and is more certain than the jacket. Superheat is good all along the line; it is hardly worth consideration from its thermo-dynamic side, but almost entirely as a heat carrier to the cylinder metal, and we are very much of the opinion that the main difference between one engine and another under equal conditions of pressure, &c., is simply that due to cylinder action.

Coming now to Mr. J. R. Dick's paper "Electricity Supply Meters of the Electrolytic Type," it at once occurs to one that the most important point that can possibly be raised in the discussion on any paper dealing with such meters is the question of "starting current." The Schattner copper-depositing meter is of the shunted type, like the old Edison appliance; the new Reason mercury depositing meter is also of the same character, and it is obvious that all the current will go through the shunt instead of through the meter path, until there is sufficient current passing to produce a drop in volts across the shunt at least equal to the back electromotive force in the electrolytic cell. We have recently heard of a test made with a 10-ampere, 200-volt, electrolytic meter which failed to start with two 8-C.P. lamps.

An important paper, judging from its title, is that of Mr. H. M. Hobart on "Modern Commutating Dynamo Machinery, with Special Reference to the Commutating Limits."

The difficulties of sparkless commutation arise mainly, we believe, from two causes:—

Mechanical.—The difficulty of constructing commutators of sufficient rigidity.

Electrical.—The immediate cause of sparking is the existence of violent electrical oscillations in the section under commutation. That this is so appears certain, but we have never seen it even suggested, and the conditions which give rise to these oscillations ought to be investigated. We think anyone will admit that the sparking of commutators is the oscillating action at a broken contact, not the glow of a heated conductor to which all writers attribute it.

It is pleasing to note that Mr. Gisbert Kapp will be with us again, for although he has now lived for some years in Germany, his excellent work in the Old Country will not readily be forgotten in electrical engineering circles. He will dilate on "Rating and Testing of Electrical Machinery."

In electric lighting, machinery may be rated correctly, but on traction work we have to face the fact that a 100-KW. set has a mean load of 20 to 30 KW., and is really underloaded.

We run full load tests of eight hours and knock years off the life of a machine, and the load never again averages more than about a third. One would imagine that an ordinary 50-KW. railway generator is about right for what 100-KW. sets are now asked to do. Americans recognise this, and skimp their railway generators, so that they may just pull through the full load test. They rely on the fact that the plant is usually urgently required, and cannot well be rejected, and that it will never again get so hot as on the test run. The system of tests shows that engineers have not yet grasped traction facts. We are sadly afraid that tests and rating for railway and tramway work require drastic revision, because, generally speaking, they have been formulated and laid out by electric light men who knew not traction.

Mr. E. C. de Segundo has a paper on "The Cassel Self-Regulating Water-Wheel," which will doubtless prove of special interest to turbine makers and users, but as this was fully described and illustrated in our issue of July 12th, there is no need to touch further upon it here, beyond drawing the attention of those who have available water-power which they desire to utilise, to the self-regulating properties of the apparatus.

Dr. Leybold's paper on "The Electrolysis of Gas Pipes, &c.," should certainly bring Profs. Ayrton and Perry into the arena. It is also to be hoped that if they exhibit any dreadful specimens of the awful results of leakage from electric tramlines, care will be taken to see that the right ones are brought forward, bearing in mind that the Congress is not one of the High Courts of Justice. The subject has critically been dealt with in recent numbers of the REVIEW.

There are several other papers to which we would gladly draw attention did but time and space permit, especially to that one by Mr. M. B. Field on "The Relative Advantages of the Three, Two, and Single-phase Systems for Feeding Low Tension Networks," but we must take leave of them for the nonce.

It is a question whether many of the subjects will be adequately, or even casually, discussed, for in the nine sections there are down for reading 106 papers, and only three mornings in which to dispose of them. But in any case we may expect the International Engineering Congress of 1901 to add materially to existing knowledge of many engineering problems, and a little while hence we shall possibly be able to say of it what the proprietor of a monthly magazine of about two years' standing recently said of his publication, "I think I can trace its handiwork in the promulgation of various undertakings which have made, and are making, for progress on a scale little dreamt of during even the closing years of last century."

With a few more such journals "militantly British" and "strung up to the highest concert pitch of excellence and superiority on behalf of the manufacturers of Great Britain," what need for engineering conferences?

Happily that time is not yet, and in the true interests of our country we hope that this great gathering is but the forerunner of like meetings in the future, and that their results may be so far reaching as to make it patent to all that England is still determined to retain the engineering and industrial supremacy of the world.

CAPACITY TESTS OF BOILERS.

WE have had frequent occasion to point out that many items go to make up the commercial efficiency of various kinds of plant, and that economy of fuel is by no means the final word in steam-raising practice.

Boilers are so generally tested for fuel economy, and the result stated in evaporation per pound of coal, that the true commercial economy is apt to be overlooked. Writing on this subject in the *Engineering Magazine*, Mr. G. K. Hooper cites a few examples to illustrate his argument in favour of capacity tests for steam boilers. Taking fixed charges at 10 per cent. on the investment, and 10 per cent. for depreciation, he cites first a boiler hand fired, and using natural draught. There were two boilers of 3,750 sq. ft. of heating surface each, and the total plant cost £3,112. Fuel cost 5s. 3d. per short ton (2,000 lbs.), and labour 6s. 7d. per day per man. The fuel efficiency was 68 per cent., the evaporation 7·882 from and at 212°, the evaporation per foot of heating surface was 3·23 lbs. per hour. Thus the charge per day of nine hours is made up of—

Fixed charges	£2	0	0
Fuel, 30,734 lbs.	4	6	7
Labour	0	13	3
Water	0	4	9
Total ...	£7	4	7

or nearly 8d. per 1,000 lbs. of steam.

The same plant worked to produce 4·206 lbs. of steam per square foot of heating surface required 45,326 lbs. of coal, costing as before 5s. 3d. per ton. The evaporation was 7·333, the fuel efficiency only 63·27 per cent. Labour cost as before, and the total costs per 1,000 lbs. work out at a little over 7d., or only 94·6 per cent. of the cost at the higher fuel efficiency, whilst the output of steam was 30·2 per cent. greater.

On a third trial with a duty of 5·33 lbs. of steam per square foot of heating surface, an extra man was needed to burn the 57,753 lbs. of coal. The fuel efficiency was now only 62·21 per cent., and the evaporation 7·21 lbs., but the cost per 1,000 lbs. of steam was now under 6¾d., or only 91·77 per cent. of the cost of the first test, whereas the output was now 65 per cent. greater.

In another case with labour at 8s. per day, fuel at nearly 14s. 6d., the highest fuel efficiency corresponded with an evaporation of 2·48 lbs. per square foot of heating surface, or 11·09 lbs. per pound of coal. The cost per 1,000 lbs. of steam was 13¾d. By working the plant so as to evaporate 4·9 lbs. per square foot, the cost per 1,000 lbs. of steam was reduced to 12¼d., though the capacity or output had been put up 75 per cent. The argument is that small boilers well worked at a high rate of steaming will prove more truly economical than larger plant; that mere fuel economy by no means measures the true economy of a plant, and that some form of assisted draught will enable the foregoing advantages to be best secured. There is always a natural tendency among engineers to aim at fuel economy, but this tendency should not be carried too far. Very considerable advance can be made in the evaporation per unit area of heating surface without very seriously reducing the evaporation per pound of fuel, and at the same time the fixed charges are spread over more steam. This is one of those points, however, that ought to be present in the mind of the designer. It is of little good to lay down the plant and then to lay off half of it idle in order to show commercial economy on the remainder.

POLYPHASE EQUIPMENT OF FACTORIES.

By W. WYLD, Associate Member.

BEFORE proceeding to the subject which we are to discuss this evening, I wish to express my thanks to the chairman and members of the Committee for the honour they have done me, in asking me to read the first paper after our chairman's inaugural address to this local section of the Institution.

I had a great amount of diffidence in accepting the invitation, for I felt that this honour should have been for some older member of the profession who had been longer associated with this locality, for I am a comparative stranger here.

It was urged, however, that the work upon which I have recently been engaged was a subject which would bring forth a good discussion, and it is therefore rather a subject for discussion which I wish to bring before you than a paper in the ordinary meaning.

Considering the number of the large power schemes which are now about to be started throughout this country, and seeing that one is to be right in our midst in this district, it is a very opportune time, I think, for a discussion to be held on the system upon which most of these schemes are to be worked, with particular reference to its applicability to the driving of factories, as I think it is from this source that the promoters of these schemes hope to derive a great proportion of their revenue, and, on the other hand, by which the public is supposed to be benefited.

Most of these large power schemes are to be on the polyphase system for the generation and transmission of the electrical energy, but whether it is to be distributed from the sub-stations as continuous or alternating current I am not at all sure; but I expect that this matter will very much depend upon the nature of the demand—*i.e.*, whether the consumers will have an alternating current supply or not; but if the current can be distributed as polyphase alternating current, the cost of converting it into continuous current will be saved and the cost of distribution thus diminished, and the consumer supplied at a cheaper rate per unit.

We are all fully aware of the inefficiencies of the old—the present, in too many instances—methods of driving factory machinery, whereby at least 40 to 50 per cent. of the power is lost in transmission, and probably 10 to 15 times more fuel consumed than necessary. We also all fully recognise the many and great advantages of electric driving, so that there is no necessity to here eulogise them. There are, however, great differences of opinion as to the best methods of obtaining the best results of electric driving in factories. I do not mean to enter into the pros and cons of the different systems of applying motors, &c., *i.e.*, by either single-motor

* Paper read March 27th, 1901, before the Institution of Electrical Engineers (Birmingham Local Section).

driving or group-driving, but I refer to the differences of opinion which exist upon the system of current to be used, viz., continuous or alternating.

The continuous current system has been the most commonly used until recently, particularly in this country, and is therefore the better known. For this reason I will not take up your time by describing it, as it is familiar to all of us; but as the alternating current system may not be so familiar, and as it is probable that it will be much more used in the near future, I purpose giving a closer description of it.

The alternating current system may be divided into single-phase and polyphase systems. The single-phase system, however, is not particularly adapted for motor driving, although it is perfectly practicable; the difficulty with single-phase motors being to get them to start on a load. There are, however, in this country about 80 towns supplied with single-phase alternating current, and in most of these towns there is some motor load.

Polyphase System.—Any arrangement of conductors carrying two or more single-phase alternating currents definitely related to one another in point of time may be called a polyphase system. Although this system has really only come into use to any extent in this country within the last year or two, it is by no means new.

It dates as far back as the year 1879, when Walter Baily showed, in a paper read before the Physical Society of London, how Arago's rotation could be produced by a number of fixed electro-magnets acting upon a copper disc. This paper is published in the *Philosophical Magazine* of October, 1879, which gives diagrams illustrating the principle of the invention and arrangement of apparatus. The latter consisted of a copper disc suspended in the centre on a needle-point, so as to be able to revolve. Under the disc four electro-magnets were placed, with their vertical axes equi-distant from the centre, and their poles close to the under-surface of the disc. It is interesting to note that these magnets had laminated cores. The exciting currents were supplied by two batteries, and a commutator was placed to alternately reverse the polarity of the field-magnets. Baily says: "The experiment with four electro-magnets may be readily performed by means of a commutator which will reverse the current several times per second," so he evidently recognised that reversals rapidly succeeding each other would give an increased effect.

We have here all the important features of the modern two-phase motor embodied in an apparatus invented 22 years ago.

The next important step in the development of the induction motor was made by Prof. Galileo Ferraris, who constructed several two-phase motors in 1885, which were on view at the headquarters of the American Institution of Electrical Engineers at the Chicago Exhibition. The description of these motors was only published in March, 1888; but before then two other patents for motors of this kind were taken out, one by the Helios Company, of Cologne, in May, 1887, and the other by Borel and Paccaud, in February, 1888. Then, three months later, we have Tesla's very complete specification for power transmission by two-phase alternating currents, and after that come many others. The production of a rotary field in the motor was explained by Tesla to be produced by employing two alternating currents of equal frequency, but having a phase-difference of 90°.

If we build a Ferraris motor with three instead of two pairs of magnets, and energise them by three alternating currents with 120° phase difference between any two, we shall obtain a rotary field, and so on for any larger number of phases. There is, however, no advantage in employing more than three phases, whilst the multiplication of circuits constitutes an undesirable complication, so that for practical work the choice is limited to either two or three phases.

In the two-phase system the two E.M.Fs. and currents are 90°, or one-fourth of a cycle apart, hence the relations of the currents to each other are such that the maximum of one occurs when the value of the other is zero. The windings of a polyphase machine may be combined in a number of ways, each affecting the relation of the electromotive forces of the outside conductors.

The windings of most commercial two-phase machines are interlinked. The current in one phase is 90° apart from, or in quadrature with, the other.

With a two-phase system either four or three wires may be used. A four-wire system consists of two separate circuits, deriving their currents from two independent armature windings in quadrature with each other, or from a continuous armature winding tapped at four equidistant points. These two single circuits must be balanced as nearly as possible, and for this purpose the four line wires must be carried throughout the system.

By joining any two of the four conductors in the four-wire system, a common return is made for the two circuits. This arrangement is known as the two-phase three-wire system.

It may here be remarked that a two-phase system with four wires is on a par with a single-phase two-line system; while with a three-wire two-phase system it is more costly, so far as the economy of copper is concerned.

In the three-phase system the three E.M.Fs. and currents are 120° apart, and the impulses follow each other at 60°.

Each one of the conductors successively serves as a return for the other two, the algebraic sum of the currents in the system being zero.

The windings of three-phase generators are usually connected up in one of two ways—either "star" or "mesh." In the former the coils of the armature are joined to a common junction, from which they branch starwise each to its own line.

The pressure between the ends of any two of the generator coils in a three-phase "star" system is $\sqrt{3}$ (= 1·732) times that between the common junction and the terminals of the coils.

In the "mesh" connection the coils are connected in series, and the line wires joined to points between the coils, forming a closed triangle without any common centre.

An advantage for factory distribution, when transformers are not required, is to be found in the "star" winding, as by its adoption a higher voltage can be used for the motors and a lower one for the lighting, which is a great advantage where incandescent lamps are used.

For instance, at the Patent Shaft and Axletree Company's power plant, the generators are "star" connected, the voltage between the three phases which is used for the motors being 350, whilst that from the star connection or common junction is 200, which is quite practicable for lighting circuits.

With the three-phase system as with the two-phase, three or four conductors may be used, but in this case the fourth or neutral wire which is used when the generators are "star" connected is only used for carrying the out-of-balance current, and need not be larger than about half the size of the other conductors; when the generators are connected up in "mesh" fashion three line wires are used, and then the amount of copper used is about three-quarters that required for a single-phase two-wire distribution.

In addition to the economy of copper in distribution there are other advantages possessed by the three-phase system which will be considered in the next paragraph on motors.

Polyphase motors are of two types—the synchronous and the asynchronous.

The synchronous motor is very similar to a generator in its construction. It is not adapted for use where a large starting torque or frequent starting on the load is necessary. It does not admit of independent speed regulation, and it has also the disadvantage of requiring certain station appliances, as with a generator, including some source of exciting current, which is usually obtained from some source other than the motor. From these reasons, then, it will be seen that the synchronous motor is not adapted for factory driving.

Asynchronous motors, on the other hand, are well adapted for factory driving. Their simple and substantial construction is one of their chief advantages, resulting in a minimum of cost of maintenance and attendance.

An asynchronous motor consists essentially of two parts, the stationary and the revolving part. In most modern motors the stationary part, or "stator," contains the coils through which the high pressure current passes from the line. The polyphase currents flowing through these coils produce a rotating magnetic field, this field acts upon the revolving part, or "rotor," and induces in it currents which magnetise it, so that the rotor takes the part of a magnet, but is only excited by the induced currents from the surrounding stator, hence these motors are often called "induction" motors.

The principles of operation of the induction motor are thus seen to combine both those of a motor and of a transformer, the "stator" being considered as the primary and the "rotor" the secondary.

When running without load the speed of the rotor is very nearly that of the rotating field produced in the stator, or nearly synchronous, and then there is a very small current induced in the secondary.

The magnetic pull of this current on the field produces a feeble torque, and the current taken from the line into the stator is only the magnetising current required to overcome the mechanical and magnetic friction of the motor. When running under load, the speed of the rotor falls by a small percentage, and the E.M.F. and the induced currents in the rotor increase with the difference in speeds, and a powerful torque is produced by the pull of this increased current in the rotor.

The difference of the speed of the rotor and that of the revolving field in the stator is known as the "slip," and this is proportional to a certain extent to the resistance of the rotor.

To ensure high efficiency and good regulation the windings of the rotor or secondary of the induction motor should have a low resistance.

It will be seen, then, that the greater the load put on an induction motor (up to a certain extent) the greater the slip will be, in order that, at constant voltage of supply, the motor will have a correspondingly greater turning effort.

Absolute synchronous speed is never obtained in an induction motor, for, as has already been shown, there is, even on no load, a certain amount of "slip" required to furnish the current necessary to overcome the light load losses. The fall of speed, from that at light load to that at normal rated load, will vary from 1·5 per cent. in motors of 100 H.P. to 3 or 4 per cent. in smaller motors.

It is sometimes said against the induction motor that it is inflexible in respect to the regulation of speed, but there are several methods of obtaining a variation of speed in an induction motor.

The three most usually adopted methods are:—

1. The inserting of a resistance in the rotor circuit which may be varied by successive short steps.
2. By changing the impressed voltage of the stator.
3. By changing the number of poles of the stator.

The first one is the most commonly used in factory driving, particularly in Europe, on such motors as are used on cranes or printing machinery, &c.

The range of speed demanded of such motors does not allow of the usual small starting resistance being used, which in some makes of motors, particularly American, is placed within the spider of the rotor.

An external rheostat is therefore required of sufficient size to carry the comparatively large though low-pressure current of the rotor. This external resistance or controller necessitates the use of three collecting rings for electrically connecting it with the rotor.

It has already been mentioned that the current taken by the

stator, as well as the torque, of an induction motor depend upon the ratio of the "slip" of the rotor to its resistance.

Therefore, by altering the rotor resistance the speed of the motor may be altered, and the torque and the stator current kept the same.

The second or potential variation method is effected by introducing an external resistance and impedance between the supply terminals and the stator.

By having a sufficient number of tappings on the impedance coils, a graduated variation of the impressed voltage is obtained and a corresponding variation in speed.

It is found, however, in practice that the motor thus controlled has a lower efficiency at full speed than a motor built for rheostatic control. A motor with rheostatic control has the same power factor at all speeds, whilst one with potential control has a lower power factor and efficiency at all but full speed.

The third method, changing the number of poles, is effected by winding the stator so that by the movement of a switch the number of poles is changed. Where, however, a great variety of speeds is required, this method is complicated. It also has the disadvantage of the motor only being able to run at full, one-half, and one-quarter speed. This class of variable speed motor is the most efficient at half and quarter speeds.

Of these three methods of controlling the speed the potential one is inferior to the rheostatic one, in as much as it is not so efficient, and the changing of number of poles is limited in its range. The worst feature of the best one, the rheostatic method, is that it necessitates collecting rings on the motor, but it must be borne in mind that these collecting rings carry a very low potential current, and my experience of them has been that they give no trouble whatever, and I have several running on cranes of from 5 to 20 tons, some of which are run under very severe and trying conditions.

Let us now consider the relative advantages of the polyphase motor over its rivals. The single-phase motor, though an induction motor, has the disadvantage of being unable to start on a load, as well as being invariable with respect to speed; in other respects it is similar to the polyphase motor.

Coming now to the continuous-current motor, we see the main difference is that the current supplied to a polyphase motor at the full pressure of the mains simply passes through the "stator" windings, which are quite enclosed, and without having to traverse any exposed parts such as commutators or brushes, and as these windings are stationary there is no danger of mechanical injury, and the insulation can be made very secure and so enabled to stand a higher pressure than would be permissible with a continuous-current motor.

This is the most important point in favour of the induction motor.

The revolving part, or "rotor," of the polyphase motor is always of low voltage, requiring very little insulation, and can thus be very much more strongly and mechanically built than a continuous current motor with its revolving armature, through which has to pass the full pressure current, and if this is of high voltage the winding of the armature has to be of fine wire and expensively insulated, being thus much more liable to burn out than the rotor of a polyphase motor. The continuous-current motor requires a commutator to commute the continuous current into an alternating one as it enters the armature; this necessitates the use of brushes for a rubbing contact, and these require a good deal of attention from time to time for trimming and readjustment, and the commutators occasionally require turning up pretty frequently if there is any sparking, which is often, if not always, the case, particularly when run in dirty and dusty places.

Now the polyphase motor does not require any commutator at all, and is thus freed from a very expensive and, at the best, a very undesirable part which is essential to the continuous-current motor.

Owing to the frailty of the continuous-current motor and the frequent sparking at the commutators, of late they have been made entirely enclosed; but this is undesirable, as it requires the motors to be larger and heavier for the same output, for the ventilation is not nearly so good as when open to the atmosphere, and, in addition, the various parts are not accessible.

With polyphase motors, and especially those with squirrel-cage rotors, there is absolutely no chance of the occurrence of a spark except at the starting switch, which may be placed at a distance from the motor. This is an important point when the motors are used in factories containing highly inflammable materials, or in fiery coal mines.

The sizes of three-phase motors are less and the weights lighter for the same power and efficiency than those of continuous current motors, and as there are no exposed parts, such as brushes, &c., carrying the full voltage current and no adjustment required, the polyphase motor is simpler and consequently much more suitable to be left in the charge of an unskilled workman.

Seeing these many and great advantages of the polyphase system, it is not surprising that so many factories, both old and new, are now being equipped with this system of driving.

It is not many weeks since I heard one of the leading continuous current engineers in the Midlands (and I believe he is here to-night) remark that even yet, with all the talk there is about the absolutely non-sparking continuous current motors, he had great difficulty in getting a really satisfactory continuous current motor, for he said "Even those of the best and well known makers, after he had had them running a few months or a year, showed their weak points and gave trouble."

It is often remarked that the polyphase system, although best adapted for motor driving, is not adapted for lighting. I do not think that any one would think of putting down a polyphase plant for lighting alone; but the advantages which it holds over other systems for motor driving are much greater than the objections raised against it for lighting, and warrant its adoption in such places as factories, and my experience is that by distributing the lighting evenly between the phases no difficulty whatever is experienced.

(To be continued.)

CURRENT SPECIFICATIONS.

LXXVI.—LOWESTOFT LIGHTING EXTENSIONS.

Summary.

Extent of Contract.—Section A. Supply and erection of one 500-KW. steam dynamo. Section B. Addition of extension dynamo positive and negative panels to the existing switchboard.

Stipulations as to Foundations.—See comments below.

Type of Engine.—To be vertical compound enclosed type.

Specified Speed.—Not to exceed 300 revolutions per minute.

Steam Pressure.—150 lbs. per sq. in., the station working exhausting to atmosphere.

Range of Governing.—Permanent variation between no load and full load not to exceed 2 per cent., momentary variation when whole load is suddenly removed not to exceed 7 per cent.

Specified Overload.—20 per cent. over normal full load for one hour without injury.

Output of Dynamo.—To give as compound-wound machine 0 to 1,000 amperes at 500 to 550 volts, or 550 KW., and as shunt machine 1,100 amperes at a voltage variable between 460 and 500 volts, or 550 KW.

Permissible Temperature Rise.—After six hours' full load run, 70° F. above surrounding atmosphere measured by resistance method.

Guaranteed Steam Consumption.—Not to exceed 33 lbs. per KW.-hour at normal full load working with ordinary dry steam at 150 lbs. pressure exhausting to atmosphere. Lowest guaranteed figure for three-quarters and half load to be stated. If tested at engine builder's works before delivery, working condensing with 25-in. vacuum, the steam consumption at full load per KW.-hour must not exceed 27 lbs.

Specified Date of Completion.—To be stated in tenders.

Penalty for Late Completion.—*One per cent.* of contract price per week.

Terms of Payment.—80 per cent. of value of work delivered and executed on site; 10 per cent. on completion; 10 per cent. at end of 12 months.

Period of Maintenance.—Twelve months from date of completion.

Stipulations as to Removal of Foreman.—Satisfactory.

Stipulations as to Wages paid to Workmen.—Trade union rates to be paid.

Stipulation as to Arbitration.—Satisfactory.

Date for Receipt of Tenders.—September 9th, 1901.

This specification is issued under the joint names of Mr. W. C. C. Hawtayne, M.I.E.E., the consulting engineer for the original scheme, and Mr. G. A. Bruce, A.M.I.E.E., the resident engineer to the undertaking. It is little more than a year since the station was opened, yet this is the second extension plant which has been found necessary.

Since, in our issue of November 2nd last, we commented upon the general conditions attached to the specification, and stated that, in our opinion, they were generally of an acceptable character, there is no need to further notice them here.

It will, however, be noted that tenderers must be able to show plant of similar size and type to that offered by them in satisfactory daily use in some central station.

It will be necessary for the successful contractor to pay very special attention to the question of foundations. A concrete and iron raft has been constructed over the whole area of the engine house, and girders for supporting the foundations are to be supplied and fixed to this by the contractor. The Corporation will fix the foundation to drawings and dimensions supplied by the contractor, but the whole of the responsibility for the sufficiency of the same will rest with the contractor, and he is specially warned to carefully guard himself from the possibility of mistake.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester and Birmingham, to whom all inquiries should be addressed.

16,166. "Improvements in relays." H. W. Sullivan. August 12th.

16,169. "A new or improved application of electro-plating." S. V. Dardier. August 12th.

16,175. "An improved escapement for electro-magnetically controlled clock and like mechanism." H. H. Grenfell. August 12th.

16,182. "Improvements in connecting-boards for use in junction boxes and the like for mutiple electric cables." G. G. M. Hardingham. (E. Waskowsky, Germany.) August 12th.

16,227. "Electric engine." H. Von Kramer. August 13th.

16,250. "Improvements in or relating to automatic circuit breakers.' L. L. Elden. August 13th. (Complete.)

16,271. "Improvements relating to electric cables." J. D. Peachey and W. J. Rice. August 13th.

16,276. "Improvements in electric automobile motors." C. Richter and R. T. Eschler. August 13th.

16,277. "Improvements in electric traction motors." C. Richter and R. T. Eschler. August 13th.

16,283. "Improvements in or connected with arc lamps." W. J. Davy. August 13th.

16,303. "Improvements in connecting overhead trolley and other bare wires." E. Hopper. August 14th.

16,319. "Application of the law, according to which the electromotive force produced in a conductor moving in a magnetic field is varying with its speed to indicate the number of revolutions per unit of time made by a turning body." G. Scialpi. August 14th.

16,340. "Improvements in means for electrically operating railway switches." F. N. Riggs. August 14th.

16,388. "Improvements in ships' telegraphs, and signalling apparatus of a like nature." A. R. Upward. August 15th.

16,395. "Improvements in the electrolytic production of bleaching solutions and in apparatus therefor." E. L. Thorp. August 15th.

16,419. "Improvements in frogs or points and crossings to be used in connection with overhead conductors of electric tramways or railways." H. G. Nicholson. August 15th.

16,423. "Improvements in magnetic devices to restore and aid the hearing." S. G. Payn. August 15th. (Complete.)

16,428. "Improvements relating to scale changing devices for electricity meters and means for operating them." W. Mathiesen. August 15th. (Complete.)

16,450. "A new or improved insulated guard for electric tramway vehicles." E. J. Rowland and T. R. Fowler. August 16th.

16,460. "Improvements in electric alternating current transformers and accessories thereto." G. Wilkinson. August 16th.

16,477. "An apparatus for electrically controlling the operation of railway points and signals." A. H. Johnson. August 16th.

16,527. "Improvements in or relating to magneto-electric and other ignition devices." W. McNeil and J. Ridley. August 17th.

16,566. "Improvements in storage battery plates." A. T. Davies. August 17th. (Complete.)

16,596. "Improvements in telephonic apparatus." P. Germain. August 17th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

17,454. "An improved support for overhead electric conductors on electric railways, tramways, and the like." A. Anderson and J. M. Anderson. Dated August 29th, 1899. Electric railways and tramways with overhead conductors. Supports, crossings and switches for conductors. The trolley wire is held by a cam in a groove formed by vertical flanges. The cam piece is slotted where it is secured by the pivot bolt, and is tightened up by bolts through lugs on the cam and flanges. Guiding ribs for the trolley wheel are formed on the underside, and curved flanges on the extended parts of the vertical flanges receive the wheel flanges to prevent sparking. The invention is applicable also to a switch or turn-out. 3 claims.

18,173. "Improvements in telephonic systems and in apparatus therefor." M. Byng and F. G. Bell. Dated September 8th, 1899. Relates to that form of telephone system by which a number of subscribers are connected to a central station by common call and return wires, together with separate conversation wires for each subscriber. 6 claims.

22,809. "Improved manufacture of magnet cores with ventilating passages for transformers and the like." O. T. Blathy. Dated November 15th, 1899. Cores for transformers, &c., are built up so as to leave ventilating passages. The iron laminæ are arranged in groups, and members of the groups have the ends turned up or down to form channels. The ends may be turned up symmetrically or otherwise, and may be arranged to interlock. 2 claims.

22,813. "Improvements in microphones." J. Egger and A. Pollax. Dated November 15th, 1899. A microphone is formed with the centre pin of the diaphragm connected to a horizontal rod of carbon situated in the upper part of the granule chamber. 1 claim.

22,830. "Improvements in primary batteries." S. Robinson. (S. R. V. Robinson.) Dated November 15th, 1899. The battery consists of a box provided with a lid in which are placed carbons, porous vessels and zincs. The carbons have reduced lower ends which protrude through the bottom of the box. The bottom of the box and the connecting wires between the plates are covered with a layer of acid-proof cement. The zincs are either suspended from copper hooks which project from the porous vessels or stand on conducting slobs and lie against studs which project them forward toward the carbons. The cover is made hollow and filled with an absorbent into which the gases evolved pass through perforations in the cover. 6 claims.

22,857. "A medicinal light curative apparatus for the production of complete or partial baths of chemical and electrical rays of light. L. Curlow. Dated November 16th, 1899. For giving "complete or partial baths of chemical or electrical rays of light," the patient is swung in a hammock in a bedstead-shaped box with springs around through which light from various sources can be directed upon the different limbs, &c. 2 claims.

22,860. "Improvements in electric insulating devices." H. H. Lake. (L. McCarthy). Dated November 17th, 1899. Insulators for various purposes are constructed with the metallic portions separated by compressed layers of mica laminæ or other pieces, alone or in combination with other insulating material such as is employed for surrounding the securing shell. 3 claims.

22,889. "Improvements in electric tramways or railways on the slotted conduit system." F. Hewer. Dated November 18th, 1899. Electric railways and tramways on the conduit system. The conduit is made of two Z or] sections, or of one such section along side one of the rails. They are tied to the rails, and rest on the depressed central parts of the sleepers, and a concrete bed to form the bottom of the conduit, and the ends of each pair of lengths are connected to cast frames which contain hinged access doors. The tops of the sections are above the rails, and gratings and pipes provide for drainage of the road and conduit. Holders attached to the webs of the sections receive the insulators which hold the conductors, suitable packing being interposed between the parts. The insulators extend above and below the conductors, and beyond the holders into which they slide. 9 claims.

23,021. "Improvements in or relating to electric motor road vehicles." H. Sefton-Jones. (Kolner Accumulatoren-Werke Gottfried Hagen.) Dated November 18th, 1899. Relates to the arrangement and mounting or supporting of the electric motors of a motor car with independently-driven swivelling steering wheels. 2 claims.

23,040. "Improvements in or relating to apparatus for the electrolysis of alkaline chloride solution." A. J. Boult. (F. Stormer.) Dated November 18th, 1899. Relates to apparatus for electrolysing an alkaline chloride solution, whereby recombination of the ions is prevented. A mercury cathode, and an arrangement for causing the minute bubbles of chlorine given off to collect together before leaving the electrolyte, are employed. 2 claims.

23,047. "Improvements in radio-conductor tubes or electric coherers." E. Ducretet. Dated November 18th, 1899. A coherer is provided with a reserve or store chamber for the filings or metal grains communicating with the tube proper, and permitting regulation of the sensitiveness by the passage of the metal particles from one limb to the other. The tube may be exhausted, or may contain an inert gas, or mercury vapour. 3 claims.

23,054. "Improvements in coupling appliances for the electrical conductors of electrical railway and tramway vehicles." Siemens Bros. & Co., Limited. (Siemens and Halske Actiengesellschaft.) Dated November 18th, 1899. Couplings for the conductors of electric railway, &c., vehicles, in those cases in which the electrical energy is transmitted from one vehicle to another. Bars carrying contacts are pivoted to brackets on the cars, and engage when the cars are coupled. Contact is maintained by the weight of the bars, or by means of springs, or by magnetic attraction. 2 claims.

23,055. "Improvements in current collecting apparatus for the underground conductors of electric railways and tramways." Siemens Bros. & Co., Limited. (Siemens & Halske Actiengesellschaft.) Dated November 18th, 1899. So that the collector can be withdrawn from the conduit, the frame carrying the pivoted shoe is turned by pins on the sliding shaft, engaging spiral slots in one of the bearings of the frame on this shaft. A collar on the shaft also acts on the tail end of the shoe, and withdraws it from the conductor on which it is normally pressed by a spring. 3 claims.

23,100. "Improvements in electric lamp supports." H. Long. Dated November 20th, 1899. An arc lamp is raised to an overhanging tubular arm of a post by a chain, which passes over guide wheels in the arm, and under and over sprocket wheels within the lower part of the post, one of these wheels being on a shaft provided with a ratchet wheel to engage a detaining pawl, and with a removable handle. When raised, the lamp is held up and connected in circuit by latches pivoted in an open frame on a tubular arm, engaging under insulated plates bolted to the head of the lamp and connected with its terminals. The latches contain conductors which bear on the insulated plates, and on plates fixed in the frame and connected to supply conductors. Three latches are provided, one acting as a support only. A pin on the lamp enters a groove in the frame to prevent the lamp turning. To allow the lamp to be lowered, it carries three radially-sliding blocks, having dovetail grooves in engagement with projections on a wedge, and a split expanding ring is suspended by headed pins in the frame. To release the lamp, it is raised until a flanged plate on it turns the latches outward; the wedge is then forced into the split ring, and against the top of the frame, so that it pushes out the blocks. The lamp is then lowered. Holders for incandescent lamps.—The cap of a lamp is provided with a flange, under which latches engage, carried by the lampholder. The latches contain conductors to connect plates on the flange with plates in the holder. The outer ends of the latches are accessible to release the lamp. 4 claims.

23,141. "Controlling arrangements for switches for direct-driven cage hoists." J. Goddard. Dated November 21st, 1899. Relates to controlling motors for cages, hoists, cranes, &c. Reference is made to Specification No. 5,423, A.D. 1898. 7 claims.

23,153. "Improvements in switches for use with rheostats for starting and controlling electric motors for lifts or the like." H. Hirst and F. O. Hunt. Dated November 21st, 1899. Switches for starting and controlling motors for lifts, &c. The contact lever is operated by a ratchet and pawl mechanism connected to the mechanism controlled. A construction is described in which the switch arm is mounted on a ratchet wheel and is fitted with a brush rubbing over resistance contacts. A pawl carried by a pin sliding in a slot in a lever is adapted to engage with the ratchet wheel to rotate it. The lever is operated by a rod and the pawl is thrown out of action, when no current is passing by a rod having a cam face. The position of the latter rod is controlled by an electromagnet or by suitable mechanism connected to the brake lever. The switch may be returned to its starting position by a spring or weight connected to a cord. 3 claims.

23,154. "Improved electrical indicator." A. Eckstein and H. J. Coates. Dated November 21st, 1899. Relates to electrical indicators in which the flag, semaphore arm, or other indicating device is operated and replaced electrically. 1 claim.

23,219. "Improvements in or relating to electric signal alarm and safety devices for railways." A. J. Boult. (F. Cument.) Dated November 21st, 1899. The ordinary signal is provided with a contact which connects the contacts in the circuit of the track battery when the signal is at "danger." The battery circuit is connected with the insulated rails mounted between the ordinary rails, the insulated rails being adapted to make contact with the brushes, &c., mounted on the locomotive or tender. When the train passes a signal at "danger" the circuit of the track battery is completed through the relay magnet on the engine, and the armature closes the contacts. One contact closes a local circuit which keeps a magnet energised, while the other contact closes a second circuit from a battery through the bell whistle or other indicator. 3 claims.

23,283. "Improvements in systems of electric distribution." The British Thomson-Houston Company, Limited. (E. Thomson.) Dated November 22nd, 1899. Relates to arrangements for cutting out a transformer or other translating device in which the insulation is imperfect. A magnetic cut-out controlled by a leakage current is arranged in the circuit. 9 claims.

23,284. "Improvements in systems of electrical distribution, and in cut-outs therefor." The British Thomson-Houston Company, Limited. (E. Thomson.) Dated November 22nd, 1899. Relates to arrangements for cutting out a transformer or other translating device in which the insulation is imperfect. A cut-out arrangement is controlled by the leakage current. 14 claims.

23,285. "Improvements in electric arc lamps." The British Thomson-Houston Company, Limited. (E. W. Rice, jun.) Dated November 22nd, 1899. A clutch or other lamp, for use on a polyphase, alternating, system, is provided with several parallel stationary electrodes, each connected to one of the supply mains and with one thicker movable electrode which is connected through a regulating coil with a neutral return conductor. The stationary electrodes are placed so far apart as to prevent arcs from forming directly between them, and an arc is maintained from them to the movable electrode, even with very low frequency. 6 claims.

23,287. "Improvements in producing high vacua." The British Thomson-Houston Company, Limited. (J. W. Howell.) Dated November 22nd, 1899. Phosphoretted hydrogen is admitted to incandescent electric lamp bulbs, and other vessels after a preliminary exhaustion, in order to decompose or mix with the residual or occluded gases and facilitate their removal. 4 claims.

23,288. "Improvements in enclosed electric arc lamps." The British Thomson-Houston, Company, Limited. (O. N. Wiswell.) Dated November 22nd, 1899. A cover for an arc enclosing globe with an elongated channel connecting the enclosure with the atmosphere, of sufficient capacity to receive the gas displaced if the upper carbon moves into the globe, and so that this gas returns to the enclosure if the carbon subsequently moves outward, without admitting fresh air. Less resistance to movements of the gas is offered by the channel than by leakage between the cover globe and carbon. In the cover in vertical section, circular grooves adjacent to the carbon and the neck of the globe impede passage of gas. Another circular space communicates by a vertical hole with a horizontal spiral channel, open at its outer end, and formed by a groove, and a flat lid screwed thereon. 12 claims.

23,289. "Improvements in controlling devices for electric motors." The British Thomson-Houston Company, Limited. (W. B. Potter.) Dated November 22nd, 1899. Means are provided in motor controllers for preventing an excessive current from being supplied to the motors. 8 claims.

23,293. "Improvements in trolley stands for electric railways." The British Thomson-Houston Company, Limited, and F. Samuelson. Dated November 22nd, 1899. This specification cannot be described without reference to drawings. 4 claims.